Historic, Archive Document

Do not assume content reflects current scientific knowledge, policies, or practices.

2

UNITED STATES
DEPARTMENT OF AGRICULTURE
LIBRARY

BOOK NUMBER 1
Ag85H
v.1
1877

350383

A. 2

REPORT

UPON

FORESTRY.

PREPARED

2132

UNDER THE DIRECTION OF THE COMMISSIONER OF AGRICULTURE, IN PURSUANCE OF AN ACT OF CONGRESS APPROVED AUGUST 15, 1876.

BY

FRANKLIN B. HOUGH.

Library, U. S. Department of Agriculture,
Washington, D. C.

WASHINGTON:
GOVERNMENT PRINTING OFFICE,
1878.

FORTY-FIFTH CONGRESS, SECOND SESSION.

Resolved by the House of Representatives (the Senate concurring), That there be printed 25,000 copies of the report upon forestry, transmitted by the President to Congress from the Commissioner of Agriculture on the 13th day of December last; 15,000 copies thereof for the use of the House of Representatives, 7,500 for the use of the Senate, and 2,500 copies for the Commissioner of Agriculture: *Provided, however*, That the total number of pages of said report shall not exceed six hundred and fifty.

Passed by the House of Representatives March 26, 1878.

Passed by the Senate April 4, 1878.

To the House of Representatives:

I transmit herewith a special report upon the subject of Forestry by the Commissioner of Agriculture, with the accompanying documents.

R. B. HAYES.

EXECUTIVE MANSION,
December 13, 1877.

DEPARTMENT OF AGRICULTURE,
Washington, D. C., December 13, 1877.

SIR: By the provisions of "An act making appropriations for the legislative, executive, and judicial expenses of the government for the year ending June 30, 1877, and for other purposes," approved August 15, 1876, the Commissioner of Agriculture was required to appoint some man of approved attainments, and practically well acquainted with the methods of statistical inquiry, with a view of ascertaining the annual amount of consumption, importation, and exportation of timber and other forest products; the probable supply for future wants; the means best adapted to the preservation and renewal of forests; the influence of forests upon climate; and the measures that have been successfully applied in various countries for the preservation and restoration or planting of forests; and to report upon the same to the Commissioner of Agriculture, to be by him transmitted in a special report to Congress.

On the 30th of August, 1876, Hon. Frederick Watts, then Commissioner of Agriculture, appointed Dr. Franklin B. Hough, of Lowville, Lewis County, New York, to the discharge of this important duty.

Dr. Hough seems to have diligently prosecuted his investigations and inquiries, not only throughout the United States, but also in foreign lands, entering into a correspondence with officers of foreign governments connected with the forest management and forestry schools in Europe, where the vital importance of this great interest is well understood, and where for many years an intelligent and settled policy has prevailed, looking to the increase of the woods. The equal and seasonable distribution of the rain-fall, the maintenance of forests upon the higher lands, and the consequent preservation of the regular supply of water to the springs, rivulets, and rivers, and the prevention of the terrible floods which wash bare the unclothed mountain slopes, and by sudden overflows destroy the agriculture and the manufactures of the valleys, are also subjects of anxious observation in this connection.

While the information Dr. Hough has acquired from these sources has been extensive and in some cases exhaustive, and while from the European modes much may be learned,—the differences that exist between our own and foreign countries in the ownership of lands, make it impracticable to apply for the present, if ever, the systems of administration that prevail elsewhere. Differences exist also in climate, and in the native trees suitable for forest culture; yet there is a very large amount of information collected in the report which is not more valuable for practical use than it is for suggestive thought.

The forest codes of Europe have for us much that is interesting and instructive, in so far as they show to what extent the public welfare may justify governments in imposing restraints upon the enjoyment of forest

property held by private owners, and in so far as they illustrate the application of those fundamental principles which may justify a government in the exercise of its right of eminent domain. If our general and State governments cannot own and rear up forest plantations, as is done in Europe, where governments, communes, and public institutions own large tracts of land, they have a duty no less important in doing what cannot be done by individuals, in the collection of facts, and in the wide diffusion of information which may prompt the self-interest of our citizens to do that personally which cannot well be done by government in the settled States of the Union under our present system of widely distributed power.

The question of timber culture upon the great plains and timber preservation upon lands yet in possession and ownership of the general government is a problem of a different character, and one of the most interesting that can occupy the attention of statesmen. Successful forestry, in its very nature, necessitates an entire change in our careless methods and shifting, changeful habits, and compels us to do whatever is done thoroughly well, and to persevere in the well-doing; to select men fitted by nature for the occupation of foresters, and to secure them a life estate or a good-behavior estate in these occupations, is the lesson taught by our European contemporaries.

The growth of trees fit for civil and naval architecture is a work of generations, and, while not difficult under ordinary circumstances, requires a steadiness and constancy of purpose, application, and culture which has not as yet received any prominent illustration in our unsteady politics and legislation.

The author of this report has compiled, with wonderful industry and apparent accuracy, statistics of the most valuable character, embracing statements of the exportation of every class of forest products from each part of the United States to each foreign country from the organization of our government to the present time, and has summarized these tables by coasts and grand divisions, and in this particular the report may be regarded as entirely exhaustive.*

Other statistical tables of great interest are presented, which from the nature of the subjects are interesting, but from the want of time are incomplete, although valuable.

The report is also accompanied with illustrations of various kinds, and especially such as apply to the graphic method of presenting statistical facts and scientific comparisons when numerically expressed. Besides the chapters which deal with statistical and strictly scientific facts, the author has a wealth of matter, historical and instructive, which will be of interest not only to every agriculturist and land owner, but also to every thoughtful person whose views of life and its duties are not bounded by the narrow limits of his own existence, or whose national pride and patriotism hope for a prosperous future for his country.

In conformity with the law above recited, I herewith transmit the report, and respectfully recommend that it be stereotyped and printed in two volumes—the more strictly scientific and tabular portion in one, and that which is of common and universal interest in the other. By this method, editions of the work may be ordered from time to time, according to the demand, and as those persons desiring the tabular and scientific part will be fewer in number than those wishing for the more discussive and more generally interesting part, a large saving of money may thus be made.

* The printing of the statistical part of this report (here referred to by the Commissioner of Agriculture) has been deferred, by decision of the House Committee on Printing.—H.

I also respectfully recommend the appropriation of $8,000, or so much thereof as may be necessary during the next year, to prosecute these inquiries into the subject of forestry—$6,000 of which to enable Dr. Hough to continue the work he has so well begun, and for which he has so much really valuable matter in hand ready to be arranged, as well as to enable him to make personal inspection of European forests, if advisable.

I respectfully submit the above to the Executive, for transmission to Congress, in compliance with the terms of the act constituting the Commission on Forestry.

Very respectfully, your obedient servant,

WM. G. LE DUC,
Commissioner of Agriculture.

To the PRESIDENT.

LOWVILLE, N. Y., *December* 8, 1877.

SIR: I have the honor to transmit herewith a Report upon Forestry, prepared by me under an appointment made by your predecessor in office, in pursuance of a provision contained in an act of Congress approved August 15, 1877, entitled "An act making appropriations for the legislative, executive, and judicial expenses of the government for the year 1877, and for other purposes."

Very respectfully, your obedient servant,

FRANKLIN B. HOUGH.

The Hon. WILLIAM G. LE DUC,
Commissioner of Agriculture.

REPORT UPON FORESTRY.

In entering upon a consideration of the points of inquiry specified in the law under which this report is made, it is not deemed necessary to present facts tending to show the importance of a suitable supply and proper distribution of woodlands in the country, nor to urge the necessity of forest products for the supply of these materials for the daily wants of life, and the manifold uses to which they are applied in the arts. It is believed that no differences of opinion could arise as to the close dependence of our national welfare and individual comfort upon the maintenance of these supplies of wood and wood-products, or upon the importance of having a sufficient amount within convenient distance, and at moderate prices, through an indefinite period of coming time.

So abundantly supplied were the older States of the Union with a native-timber growth, that questions relating to permanence of the supply appear not to have suggested investigation through a long period, and in fact the great excess of forest over amount required for proper use, led at first to the clearing off of extensive regions to prepare the soil for cultivation, without yielding in return any direct benefit from the product other than the value of the potash made from the ashes. The misfortune has been, that this clearing was made without a thought as to the probable wants of the future, either for supply of materials for building, manufactures, and fuel, or for value of reserved belts of timber as a shelter from sweeping winds; and, as a consequence, the supplies have within a few years past been found scarce, and their prices have advanced to a degree that is sensibly felt by all classes of the population; for we cannot enhance the cost of building-materials, or of implements of wood, or the cost of fuel, without its being felt everywhere. Wherever these increased values affect the cost of building and maintaining ships or railroads, the expense of transportation is proportionably increased, as well upon freights of every kind as upon the cost of travelling.

In the prairie States and in the Territories, the absence of forests has been felt severely from the beginning, and the want, so far as relates to lumber, timber, and fuel, has been supplied at more or less sacrifice by bringing these materials from other sections of the country where they grew. This necessity has in these regions, brought the question of forestry before our citizens as one of practical importance, so that we find throughout the treeless portions of the country, a more general interest in the subject, than in those sections where the want has not been as yet materially felt. But in these older and naturally well-timbered sections of the country, thoughtful persons have for years been watching the wasting of supplies and the complete exhaustion of one forest region after another with an anxiety natural with those who look forward to the probable conditions that must necessarily exist in another generation, and who feel the responsibilities of the present with regard to the future.

Beginning, therefore, with the statement accepted as without denial, that a proper supply of forest products is indispensable, and that shade and shelter are of incalculable value to our agricultural interests, we may notice some facts that depend upon the rights of property in wood-

lands, as they exist in our country, and compare them with the conditions that prevail in other countries. We shall find that in Europe, and especially upon the continent, there are extensive tracts of land belonging to the general government or to local municipalities, or to institutions, and that over these a system of management has grown up, under different circumstances, and that at present, although there is a great diversity in the details, they all agree in this, that the management should be conducted without needless waste, and for the best interest of the owners. In many cases this system includes rights of enjoyment among the inhabitants of the commune, by which the land is owned; and not infrequently these rights, originating in customs of great antiquity, and, perhaps, in the beginning, of doubtful authority, have proved a serious obstacle to management under an enlightened code, by allowing practices that tend to ruinous results. In a subsequent part of this report some of these systems will be presented somewhat in detail; but they will prove with us of historical value, rather than of practical interest, because our circumstances are so different that they present few precedents for our guidance.

The tenure of lands within the United States is almost everywhere allodial; and, excepting as it is still held by the general or State governments for specific public uses or for future grant or sale, the land consists of freehold estates, the absolute property of the owners, without being subject to quit-rents, service, or acknowledgment to any superior. Excepting as he may pledge his estate for the security of a debt, the owner has no other obligation to others, further than to bear his just share of the expenses of government for the general protection of property and the maintenance of good order. The government still, however, reserves a right of eminent domain, under which private property may be taken, upon payment of its value, when needed for the public good; and under this right a qualified power is vested in the government for restraining from the use of private property where it may affect the rights of others.

Neither our national, State, nor local governments are the owners of land upon which timber can at present be planted and cared for until maturity at the public cost, with the least prospect of success. Where a government is administered by officers elected by the people, and where any citizen may be chosen to any office, and especially where these offices have a patronage that makes them especially desirable, they become at once objects of political ambition. Special qualifications for particular stations in public life afford no promise of employment, nor of continuance if employed, and hence we have no inducements to offer a young man who might aspire to a position for which he might have great native ability, and for which he would be willing to undertake the most thorough special education if he felt assured that employment would depend alone upon the most thoroughly approved preparation, or the most rigid examination. Hence it cannot, at least at present, be expected that our governments can undertake the practical management of forests, as is done in Europe, by officials specially trained for this pursuit, with the view of deriving a benefit from the cultivation. They can scarcely do more than prevent depredations upon the timber already growing, if, indeed, they succeed in this, where the property to be protected is not immediately under the care of a resident agent, who truly feels the responsibility of his trust, and is able to discharge its duties.

The experiences of pioneer life, as regards the timber, present little that can be commended and much that can be blamed. It has been observed in all countries and at all periods, that trees furnishing products

demanded by commerce, or standing in the way of cultivation, become an object of inconsiderate waste, and not unfrequently to such degree that the markets are overstocked, and ruin is brought upon the greedy but thoughtless adventurers in a business liable to bring an over-supply. This tendency has been exemplified over and again in our lumber and timber trade, and illustrations are too numerous and too recent to need mention. But, aside from the conceded propriety of proper clearings for cultivation in forest regions, the opportunities for trespass are too open and inviting to be resisted by the class of settlers who generally make the first and furthermost advances in frontier settlement; and too often the forest history of our most valuable woodlands would be a record of the doings of timber-thieves. The growth best suited for lumber, or timber, or shingles, or staves, has been taken where most convenient, without regard to ownership, and the products of this stealthy industry have been sold to unscrupulous dealers, who may have made small advances in supplies, well knowing from whence the returns would come. Finally, to cover these proceedings, fires may be set to burn up all traces of evidence, and when once started in the shavings of a shingle-camp, or among the dry brush of a timber-cutting, these fires may cause infinitely more damage than the depredations they were intended to conceal.

Such regions, when plundered, have sometimes grown up with an inferior class of timber or have been occupied by a more substantial class of settlers, by whom the first permanent improvements have been made. These descriptions of forest-waste are by no means local or applicable to particular regions, although they may vary according to circumstances and opportunity. The Saint Lawrence frontier of New York was stripped of its best oak-timber by thieves from Canada before settlement began. The pine-regions of Pennsylvania suffered greatly before notice was taken or measures adopted for preventing it, and the mining regions of the West present instances of waste far exceeding any that we meet with elsewhere.[1]

TIMBER RESERVATIONS FOR NAVAL CONSTRUCTION.

Reservations of timber fit for ship building were common in the patents granted for land in the colonial period, and the exportation of timber was from an early period an important item of industry and source of profit to the colonists.

The earliest measures taken by the Federal Government for the establishment of a Navy were under an act approved March 27, 1794, authorizing the President to provide four ships of forty-four guns, and two ships of thirty-six guns each, for the purpose of protecting American commerce against the depredations of Algerine corsairs. A small Navy had existed under the government of the old confederation, but from 1785 until the first ships were launched under the act above noticed in 1797, there was none.

---

[1] Mr. R. W. Raymond, in his second Report on Mines and Mining (1870), in speaking of the mining-interests of the Pacific States, says: "In this connection I desire to call attention particularly to one of the worst abuses attendant upon the settlement of the mining regions and other portions of the West. I allude to the wanton destruction of timber. This reckless and disastrous practice was extensively prevalent in the heavy fir and cedar forests of Oregon and Washington nearly twenty years ago. Timber was so abundant that to many it seemed inexhaustible, and they took especial delight in its destruction. Hundreds of square miles were burned over in a single season, and vast quantities of the finest timber in the world, easily accessible for purposes of commerce, either totally consumed or rendered utterly valueless. The same waste is yearly going on in all the Western States and Territories, and particularly in the mining regions of the Rocky Mountains." (*Report on Mines and Mining Statistics*, 1870, p. 342.)

The agents entrusted with this duty recommended the use of live-oak, being assured that, "the building of these frigates of live-oak will certainly be a great saving to the United States, as we are well satisfied (accidents excepted) that their frames will be perfectly sound half a century hence, and it is very probable they may continue so for a much longer period." The experience of the Navy fully justified this prediction. The importance of securing a sufficient supply of timber for the Navy was upon that occasion strongly urged,[1] and this finally led to an act approved February 25, 1799, appropriating $200,000 for the purchase of growing or other timber, or of lands on which timber is growing suitable for the Navy, and for its preservation for future use.

It will be remembered that Florida and Louisiana, extending along the entire Gulf coast and including most of the live-oak known to exist, then belonged to foreign powers, and that the amount of this timber within the Union as then bounded, was of very limited extent. Small purchases were made on the Georgia coast under the act of 1799,[2] but nothing of importance beyond this was done until 1817. On the 1st of March of that year an act was passed directing a reservation of such public lands, having a growth of live-oak or cedar timber suitable for the Navy as might be selected by the President.[3]

Under the act of 1817, surveyors were appointed, and a reservation was made upon their report of Commissioners, Cypress and Six Islands, in Louisiana, containing about 19,000 acres, and, as was supposed, about 37,000 live-oak trees fit for naval use, but some of them difficult of access.

In 1828, the sum of $10,000 was granted for the purchase of lands for the supply of live-oak and other timber for the Navy, and about 3,650 arpents were bought on Santa Rosa Sound; and during two or three succeeding years a system of cultivation was undertaken.[4]

---

[1] "It will be well to consider that great quantities of the finest live-oaks are destroyed to clear the lands, and that some of the maritime countries must resort to this country for timber, which will, in a few years, put it out of the power of the United States to secure the quantity of timber they will most assuredly want, without paying an exorbitant price. If they were to purchase some of the islands plentifully timbered with live-oak, I have reason to believe they may be sold for the first cost after the timber is cut off." (*Am. State Papers, Naval Affairs, i, p.* 9.)

In December, 1798, the importance of buying some of the islands on the coast of Georgia was again urged in a provision for supplying the Navy with live-oak timber. (*Letter of Benjamin Stoddert, Ib.*, p. 66.)

[2] Grover's Island (350 acres) was bought by the President December 13, 1799, and Blackbeard's Island (1,600 acres) in April, 1800, the former for $7,500, and the latter for $15,000.

[3] The acquisition of Florida brought into the United States extensive groves of live-oak, but these lands were often so encumbered by claims under former governments, that the first examinations for lands with clear titles met with poor success. It was not until 1825 that an agent could be appointed, and he found that live-oak had been a staple export from the Saint John's River for a long time. During the last six or eight years the number of vessels with this timber as cargoes, had averaged 150 a year, carrying not less than 2,000 feet each at a load, or in all nearly two millions of feet within these years. This estimate caused much anxiety, and led to a recommendation by the Secretary of the Navy (January, 1827) urging the following measures:

1. The purchase of heavily-timbered lands.
2. The reservation of sufficient lands in Florida and Louisiana after proper surveys;
3. The planting of trees upon lands already owned by the government, or that might be bought, including Grover Island already cleared; and
4. The purchase and storage of large quantities of timber, which might be kept half a century if need be with proper shelter.

[4] This consisted in grubbing out the roots of other trees and clearing the ground around the live-oaks, so as to afford them better opportunity for growth. The few trials at transplanting were mostly failures, and growth from the seed was deemed more reliable. In 1829 and 1830, some 45,000 trees, mostly from two to six inches in diameter, were thus cleared and pruned.

Information upon the subject of live-oak reservations will be found in the *American*

By another act, approved March 3, 1827, the President was authorized to take proper measures to preserve the live-oak timber growing on the lands of the United States, and he was authorized to reserve such lands in sufficient quantities to render the same valuable for naval purposes. Provision was made by an act, approved March 2, 1831, for the punishment of persons in cutting or destroying any live-oak, red cedar or other trees growing on any lands of the United States, by a fine of not less than thrice the value of the timber cut and imprisonment not exceeding twelve months.[1]

The amount of land expressly reserved under the acts of 1817 and subsequently is as follows:

	Acres.
Alabama (November 28, 1832), three half-sections in Mobile County	240
Florida (October 23, 1830, to December 19, 1860, at various times), many detached parcels, chiefly in counties bordering upon the Gulf of Mexico and Suwanee River, including the whole of Santa Rosa Island	208,824
Louisiana (October 21, 1845), Pecan, Cypress, and Navy-Commissioners' Islands	9,170
Mississippi (October 30, 1832, to April 16, 1858), many separate parcels on the Gulf coast, including Round Island	26,218
Total	244,452

OTHER RESERVATIONS OF TIMBER LANDS.

Very limited reservations for public parks have been made in recent years, as will be more fully mentioned on a subsequent page.

There have also been made special reservations of lands around military posts, but of the amount of timber thus withheld we have no statistics. The various Indian reservations include considerable amounts of timbered lands, some of which may have been selected on this account; but of these no information has ever been publicly reported, and probably none has been obtained.

TIMBER ON THE PUBLIC LANDS.

In the sale of public lands through a long period, laws have been provided for the conveyance of land in mineral districts for mining purposes by exceptional modes of entry and at discriminating prices, but no provision has hitherto been made for the sale of valuable timber tracts differently from that which applies to prairies. Our proverbially valuable "pine lands" have been held at the same prices as other lands, although notoriously unsuited to agricultural purposes when once cleared of their timber, and have been held subject to pre-emption and homestead entry, although they have often been abandoned as soon as the timber was cut off.

Under the various acts already noticed, and by virtue of decisions and judicial rulings, these statutes were held to apply to the whole

State Papers, (Naval Affairs,) i, pp. 8, 27, 38, 41, 42, 75, 482, 586, 605, 689; ii, 624; iii, 47, 50, 211, 763, 917, 918; iv, 32, 98, 104, 107, 123, 163, 191, 204, 213, 218, 219, 220, 222, 223, and 368. See also *Ex. Docs.*, Nineteenth Congress, first session, vol. v, No. 85, and second session, vol. 5, No. 114; Twenty-first Congress, second session, vol. 1, No. 2, p. 234; *Reports of Committees* (same session), vol. 1, No. 102. *Ex. Docs.*, Twenty-second Congress, first session, vol. 4, No. 178, and second session, vol. 1, No. 23.

[1] *Statutes at Large*, iv, 471; *Revised Statutes of the United States*, section 2, 461.

United States,[1] and a system of timber agencies was established under instructions from the Solicitor of the Treasury.

In 1854 these agencies were discontinued, and supervision was transferred to the General Land Office, in the Department of the Interior. In 1855 a circular was issued, which remained the basis of regulation until 1877.† Under this, the officers of the several land-offices were directed, whenever reliable information reached them that spoliations of public timber were being committed, to investigate the matter, and to seize all timber found to have been cut without authority on the public lands, to sell the same to the highest bidder at public auction,

---

[1] Some of these decisions were as follows:

Intruders may be removed by military force under act of March 3, 1807. The United States have also the common-law and chancery remedies enjoyed by individuals for protection and redress. (*Attorney-General's Opinions*, I; Wirt, May 27, 1821.)

The rights of settlers in East Florida in respect to the cutting of live-oak were defined as follows: "They are not entitled to cut live-oak or other timber, except for the purpose of clearing, until they have complied with all the conditions of the law. The conditions precedent to that right are: the obtaining of a permit; residence five years in the Territory; the erection of a house; clearing at least five acres; and actual residence four years next following the first year of the date of the permit, with proofs of these facts in manner specified." (*Attorney-General's Opinions*, IV, 221; Nelson, August 11, 1843. See, also, *Id.*, IV, 405; Nelson, July 16, 1845.)

Case of United States *vs.* Ephraim Briggs, in which it was decided that "the title of the act would indicate that timber reserved for naval purposes was meant to be protected by this mode and no other. But the enacting clause is general, and therefore cutting and using of oak and hickory, or any other description of timber-trees, from the public lands is indictable and punishable by fine and imprisonment." (*Howard's Supreme Court Reports*, IX, 351; January term, 1850.)

† CIRCULAR OF COMMISSIONER OF GENERAL LAND OFFICE (1855 to 1877).

DEPARTMENT OF THE INTERIOR, GENERAL LAND OFFICE,
Washington, D. C., December 24, 1855.

GENTLEMEN: The Secretary of the Interior has concluded to change the present system of timber agencies, and to devolve the duties connected therewith upon the officers of the local land-districts. By this direction, therefore, you will, upon the receipt of these instructions, take charge of the timber business within the limits of your land district, as a part of the general duties of your office; and it is accordingly hereby assigned to you as such, with the understanding that, hereafter, it is to be considered and held as a proper incident to, and in fact a part of, your general duties, covered and satisfied by the salary which the law provides for your respective offices.

That you may understand the nature of this part of your duties, your attention is directed to the following:

1st. Attorney-General Wirt, in an opinion of the 27th of May, 1821, holds as follows: "Independent of positive legislative provisions, I apprehend that, in relation to all property, real or personal, which the United States are authorized by the Constitution to hold, they have all the civil remedies, whether for the prevention or redress of injuries, which individuals possess. (See 3 Wheaton, 181.) So the United States, being authorized to accept and to hold these lands for the common good, must have all the legal means of protecting the property thus confided to them that individuals enjoy in like cases. * * * * They are, therefore, in my opinion, entitled to the injunction of waste by way of prevention, and to the action of trespass by way of punishment, in like manner as individuals similarly situated are entitled to them."

2d. Attorney-General Taney, now Chief Justice of the United States, in an opinion of 22d August, 1833, cites this opinion of Mr. Wirt, and concurs in it.

3d. Attorney-General Mason, in a communication of 16th July, 1845, refers to the opinion of Attorney-General Nelson, of the 11th August, 1843, and, in concurring in it, states that, "when the right of pre-emption exists, the settler who has complied with the provisions of the act of 4th September, 1841, has a right of occupancy for twelve months, within which he may perfect his title by paying the minimum price of the land. Like the settlers under the armed occupation act, his right is inchoate only; and he has only those rights of property which are necessary to the perfecting of his title. He may clear the land, build on it, and inclose it with a view to cultivation. For these purposes he may use or destroy any trees which may be necessary, but within these restrictions, and necessary fire-wood, he is confined."

The penal act of 2d March, 1831, provides "for the punishment of offenses committed

and deposit the proceeds in the Treasury. They were to bring the offense committed to the attention of the proper officers, that the perpetrators might be arrested and held to answer as usual in criminal cases. The purpose being chiefly to protect the rights of the government, these officers were instructed to consider the circumstances of the case, and they might compromise on payment of costs incurred, and a reasonable stumpage for the timber, which was then released, and prosecution waived. Until 1872 no appropriations were made for this object. It was made a rule that the expenses incurred should generally be limited to the amount realized from the sale of timber seized, and from stumpage in cases compromised; but in some cases where the expenses

---

in cutting, destroying, or removing live-oaks and other timber or trees preserved for naval purposes."

This act of 2d March, 1831, you will find fully considered in the case of The United States *vs.* Ephraim Briggs (9 Howard, p. 351), in which the Supreme Court decided that the said act authorized the prosecution and punishment of all trespassers on public lands by cutting timber, whether such timber was fit for naval purposes or not.

4th. Under no circumstances will you compound or compromise with any such trespassers, or receive any pay or compensation from them as acquittal or discharge therefrom, or in any other manner; neither will you give any permission to cut timber or otherwise trespass on the public lands, as there is no authority for any such proceeding; but all such offenses against the law must be prosecuted and tried by the authorities duly constituted for that purpose.

5th. Should you find such trespass committed on *swamp* lands, or those which are rendered unfit for cultivation by overflow, you will take no further action than to notify the governor of the State, as all such lands inure to the State under the act of 28th September, 1850.

6th. In the enforcement of the said act of 1831, you should be careful not to interfere with pre-emption rights under the act of 4th September, 1841, the settler, with a view to cultivation, having the right, as hereinbefore indicated, to use or destroy trees in clearing roads and constructing bridges, or for any other purpose connected with the improvement of his homestead.

7th. While thus liberal to the honest settler, you should be vigilant to detect and arrest the speculator, who, in the guise of a settler, and under the sanction of a declaratory statement, may contemplate the spoliation of timber, and unless arrested might seriously injure the public interest.

8th. Where the tresspassers are unknown or known, and timber has been cut or removed off the public lands, you will cause it to be seized and sold at auction to the highest bidder, under such regulations as sound discretion may suggest.

9th. All moneys, the proceeds of the sale of timber received by you, must be deposited in some of the United States depositories, to the credit of the judiciary fund, without abatement, and an immediate report made of the same to this office, with a full statement of all particulars duly verified.

10th. In the prosecution of your duties you may, upon any pressing emergency, deputize a reliable person to investigate and report the facts involved in any supposed case of tresspass, and allow a per diem of three dollars and a mileage at the rate of ten cents per mile.

In making any such appointment you will report the fact instanter, and the necessity for it, and will require in the affidavit of the employé a statement of the time actually occupied in the service and the distance traveled. An account verified by the party and certified by you should be reported to this office for payment.

Where there is no pressing emergency for the appointment of an agent, you will refer the facts to this office for consideration and await instruction.

11th. In returns to this office of sales of timber you will be careful to designate the places of seizure, the quantity and kind of timber, whether in logs or manufactured, price per foot, with the names and residences of purchasers, and cause the same to be verified by a certificate from the party making the seizure and sale.

12th. You are directed to make a report at the end of each quarter, the first to be rendered on 1st April next, of the proceedings of your office pursuant to those instructions, and showing the operations of this system as preventive means; also the number of acres entered by trespassers through its constraining influence.

You are requested to acknowledge the receipt of this, and advise me of such preliminary steps as you may take with a view to a compliance with the foregoing instructions.

Very respectfully, your obedient servant,

THOMAS A. HENDRICKS,
Commissioner.

incurred exceeded the receipts, the deficiency was made up from the judiciary fund.

In 1872 appropriations were made for the pay of agents, and these have since been continued, the sum for four years past being $5,000 a year, and the whole amount thus granted making $45,624.76. The receipts in all, from stumpage and other payment for timber taken from the public lands have amounted to $199,998.50, leaving only a balance of $154,375.74 for the many millions' worth of timber taken from the public domains.

The Commissioner of the General Land Office has repeatedly called attention to this very unwise and improper policy, and in his report for 1874-'75—repeating the language of his last report—in reference more particularly to our pine lands, he says:

The product of these lands is of universal use, and forms the staple of commerce of no inconsiderable portion of the nation. The difference between the government price and the actual value thereof is large, yet Congress provides that these lands shall be disposed of under the pre-emption laws at $1.25 per acre, or under the homestead laws by commutation, under the eighth section of the act of 1862, at the same rate. It is true that the law provides that in the discretion of the President this class of lands may be proclaimed and sold at public outcry to the highest bidder; but the experience of this office shows this method to be entirely ineffectual for the reasons, first, that under the ordinary system of surveys the field-notes cannot disclose, with any degree of accuracy, which are pine lands and which are not; and second, that there is little room for doubt that combinations are formed among purchasers at government public sales whereby prices are kept down to a merely nominal figure. The usual result is, therefore, the government receives the minimum price of the lands, *less the large expense of three months' advertising required by law.* Another and greater evil results from public sales under existing laws. This office having, as I have before stated, no reliable means of distinguishing pine lands, is reduced to the necessity of including in the proclamation all lands *supposed* to contain pine. It results that only such small proportion of the tracts proclaimed as are known to the purchasers to contain pine are sold, while the great mass of them, receiving no bid, remain with the government as "offered lands," *subject thenceforth to private cash purchase without settlement,* and become the easy prey of non-resident speculators, thus defeating the now well-established and beneficent policy of the government in that regard. The remarks here made apply as well to the "fir lands" of the Pacific as to the pine lands east of the Rocky Mountains, and are indeed of more importance as bearing on the question of the future disposals of "fir lands," since the quantity of "pine lands" remaining unsurveyed and unsold is now comparatively limited. Under this state of facts I would urgently recommend the passage of a law providing—

First. That pine and fir lands shall not be subject to entry under the pre-emption and homestead laws.

Second. That a system of survey shall be devised by which the quantity of pine or fir in each smallest sub-division of a section may be at least closely approximated.

Third. That an immediate exploration by experts of the unsurveyed portions of those States and territories known to contain pine or fir, be authorized, with the view of ascertaining the geographical situation of pine and fir districts on fields.

Fourth. That the reports of such explorations be followed by immediate survey of these districts.

Fifth. That the survey be followed by immediate appraisal, proclamation, and sale, at not less than the appraised value, and for cash only.

As I have indicated in the foregoing suggestions, I am strongly of the opinion that the wisest policy the government can pursue in respect to this class of lands is that which will most speedily divest it of title in the same for a fair consideration, for the reason that depredations to an enormous extent are constantly occurring, which existing laws are powerless to prevent, and seemingly equally powerless to punish.

In reiterating this advice, the Commissioner remarks:

It is among the traditions of this office—certified indeed by its records—that from a very early day, eagerness to acquire title from the government to these exceptionally valuable lands for speculative purposes has led to the perpetration of innumerable frauds. It is notorious that, as a rule, the soil itself of these lands possesses but limited fertility; and it is equally certain that such of them as are entered upon under the pre-emption and homestead laws, are not generally so taken with the purpose of adding value to the tract by cultivation, but rather with the expectation of profiting by the after sale of the timber growing upon it. Through the facilities furnished by that provision of the pre-emption laws which, for unoffered lands, extends to applicants a credit

of thirty-three months, opportunity is found under cover of the declaratory statement which gives to the pre-emptor protection in his possession of the tract, to strip the lands of their timber and thereupon to abandon them without even the payment of the minimum price.

These remarks were chiefly applied to lands of the class designated, lying eastward of the Missouri River, and along the Pacific coast. But a large part of the timbered region of that coast has not been surveyed, and yet already "from them have been taken the vast supplies necessary for mining and smelting operations, for the building and maintenance of railroads, and, indeed, for the supply of every form of industry and improvement within the district of country embracing the same into which timber enters as a necessary part. Data are not accessible for forming an estimate of the value of the public property thus used and destroyed without return to the Treasury."

Moreover, the great mining and smelting operations of the Pacific States depend largely upon a continued supply of timber, and it is perfectly well known that although timber of some species grows to an enormous size, and that in some districts the yield per acre is almost beyond power of belief, yet the area is not large; much of it is difficult of access, and a prudent forethought should be exercised in its preservation and economical use. Of course these lands cannot be sold until they are surveyed, and at present they are entirely without even nominal protection. As title cannot be obtained, the necessities of the country lead to the procuring of timber wherever it can be got, and thus every person having occasion to use forest products, is either obliged to commit depredations upon the public lands himself, or to procure them of others, "knowing them to have been stolen."[1]

[1] Recent investigations by a special agent of the Department of the Interior, under instructions from the Commissioner of the General Land Office, have, according to accounts published in the public journals, and reported officially to the present Congress, shown that the depredations upon public timber in recent years, have amounted to many millions of dollars. Some lumbering firms and individuals have acquired vast wealth by these operations. The pecuniary loss thus occasioned is not the only injury done. A demoralizing effect has been wrought in the minds of a certain class, who, seeing government property openly taken, under the eyes of public officers, without notice, have come to regard this class of property as common, and communistic principles of most dangerous tendencies have been encouraged.

Whatever may be the legal rights involved, it cannot be denied that timber growing upon government lands in the newer States and in the Territories, is often loosely regarded as applicable to the wants of settlers; and where it is scarce there is little hesitation in taking it wherever found most convenient. With a public sentiment justifying this course, it is idle to expect that laws or regulations alone will ever protect it, or that prosecutions tried before a jury will ever lead to conviction. The same may be said of the scanty belts of timber growing upon lands granted to railroads, and upon the lands of non-resident owners. It is even doubtful whether any regulations tending to restrain from waste or improvident use would be heeded in the absence of authority upon the spot sufficient for protection. Such native growths appear to be regarded, like wild fruits, a proper object for use wherever found, and it is not until timber is planted and cared for by an owner that it comes to be regarded as the property of the soil, to be enjoyed, like a field of grain, by the man who has planted it, or his successor in title.

These facts are stated as among the difficulties to be met in whatever measures it may be found practicable to undertake, and not in the remotest degree as a palliation, much less a justification, of the sentiment believed to exist. The inducements and opportunities for this irregular proceeding are chiefly to be found in the Territories remote from lines of communication, and they prevail most among the class of pioneers that precede the tide of permanent emigration—in fact, among those who scarcely acquire a title to the lands they despoil. It is an incident that was observed under somewhat different circumstances, in the first settlement of what are now the older States, where the injuries, although greater in amount, were less in effect, and, perhaps, where this habit of improvidence was first acquired. They may be regarded, however deplorable, as not likely to continue, as the land comes under the protection of resident owners, among whom we may expect a better sense of justice, as regards the rights of real estate.

Still worse, the system of lumbering heretofore practiced in that region is exceedingly wasteful—not more than half the timber that is felled, being used for any useful purpose whatever. The rest is left to decay, or it becomes a prey to the flames, which, finding an abundance of dry material upon the ground, throughout the lumbering region, sweep over wide districts in dry seasons, destroying not only much standing timber, but everything in the way of young shoots and undergrowth by which the slow process of reproduction may in some places have begun.

Again, in the report of 1875–'76 (a change having brought another Commissioner into office), we find the following views expressed with regard to the sale of timber lands:

A national calamity is being rapidly and surely brought upon the country by the useless destruction of the forests. Much of this destruction arises from the abuses of beneficent laws for giving land to the landless. The operation of these laws is salutary when settlements are made under them, upon lands fit for a home and cultivation by the agriculturist; but the policy, if such it may be called, of allowing the pine lands to be settled upon under the pre-emption and homestead laws is a mistaken charity, prolific of great evil. These lands, whether situated on the Atlantic or Gulf coasts of the South, the Lake Superior and Upper Mississippi regions of the North, or on the mountains of the Territories of the great interior and the Pacific coast, are alike unfit for agriculture, and in no manner meet the requirements of a home and continued residence for the agriculturist; they are valuable only for the timber growing upon them. Settlement upon these lands under the homestead and pre-emption is abandoned. In all the pine region of Lake Superior and the Upper Mississippi, where vast areas have been settled under the pretext of agriculture, under the homestead and pre-emption laws, scarcely a vestige of agriculture appears. The same is true on the Pacific coast and in the mountain regions of Colorado, Utah, Montana, and Idaho.

As a remedy for these abuses, the report above quoted suggests the reservation of lands under suitable protection, or its sale at its proper value as the demands of the country require it. To accomplish this sale. the land should be surveyed and appraised by experts, the value being based upon the amount and accessibility of the timber. There should be an absolute confiscation of timber cut upon the public lands, and a fine and imprisonment, instead of an easy settlement by compromise, as is now the custom. The sales should be for cash only, and in the mining districts a reasonable price should be required for the wood sold for mining purposes. It was believed that pine lands, honestly appraised at their true value, could be sold as fast as needed, and that the timber thus acquired would be carefully husbanded in the hands of owners, who, having paid a fair price, would desire the largest return from their investment. He remarks:

It is an anomalous fact that the government is giving away the rich alluvial soil of Iowa, Nebraska, Kansas, and Minnesota to any citizen who will plant a few acres of cottonwood or other inferior timber, while under the provisions of the pre-emption and homestead laws it is granting a license to destroy millions of acres of pine forests of almost incalculable value, which should be preserved as a nation's heritage.

He urges immediate attention to this subject, as every day of delay will continue to add largely to the already enormous losses of the government.

The system established in 1855, by a regulation of the department, in the absence of legal provision expressly defining its powers, remained in force until 1877, when the accumulated evidence of its defects led to the issue of the following:

DEPARTMENT OF THE INTERIOR, GENERAL LAND OFFICE,
Washington, D. C., May 2, 1877.

To Registers and Receivers of United States Land Offices:

GENTLEMEN: The Secretary of the Interior has concluded to change the method formerly adopted for protecting the timber on the public lands, by which you were made agents for that purpose within the limits of your respective land districts, as

per circular of December 24, 1855. Pursuant to directions from him of the 5th ultimo, the instructions of that circular are hereby revoked.

Hereafter, as it may be found advisable, from time to time, for the end in view, clerks or employés will be detailed from this office to act under instructions of the Commissioner in ascertaining when, where, and by whom depredations have been committed upon the public lands, and to report to him the facts in each case.

If, upon an examination of the reports so obtained, the Commissioner finds that the facts elicited in any case warrant the commencement of legal proceedings to punish the trespassers, or to collect damages for the waste already committed, or both, he will report the same to the Secretary of the Interior, with his opinion thereon, in order that such further proceedings may be had in the premises as the case may require.

The clerks or employés detailed as aforesaid will not be permitted to make any compromise for depredations committed on the public lands. If any propositions are submitted to them with that object, they will be required to report the same to this office, with a full statement of the facts in the case, showing the nature and extent of said depredations, when and by whom committed, the amount and value of the timber when cut, and the value of the land in its present and former condition; all of which, together with the opinion of the Commissioner, will be submitted to the head of the Department for further consideration.

If, in any case, the emergencies should seem to require more prompt action than is contemplated in the rules above indicated, in order to arrest the offender, or to secure the Government for the damages suffered, it will be the duty of the clerk or employé detailed to act in the matter to make direct application to the United States district attorney for the district in which the waste was committed to institute the proper legal proceedings for that purpose. This course, however, must be taken only in cases where the evidence is clear and indisputable.

The foregoing is communicated for your information. You will observe therefrom that you are not hereafter to act as agents for the protection of the public timber, although your co-operation is expected whenever you may be called on to render assistance to officials charged with the duty.

Very respectfully,

J. A. WILLIAMSON,
Commissioner.

It is understood that numerous proceedings have been already commenced against trespassers upon the public lands since these regulations were issued, and enough has been done in enforcing the rights of the government against those who have committed these depredations to prove that a considerable revenue may be derived from the sale of timber. But there are questions arising with regard to the future, infinitely more important than present revenues, and these will, it is earnestly hoped, engage the attention of Congress at an early day.

TIMBER-CULTURE ACTS OF 1873 AND 1874; AMENDMENTS OF 1876 AND 1877.

An act entitled "An act to encourage the growth of Timber on Western Prairies," approved March 3, 1873, was designed to offer direct encouragement for the planting of trees upon the prairies. The provisions of this act were briefly as follows:

1. Any person who should plant, and for ten years protect and keep in a healthy growing condition, *forty acres* (the trees being not more than 12 feet apart each way) upon government land, was to be entitled to a quarter-section (160 acres) at the end of the ten years, the facts to be proved by two credible witnesses. Only one-quarter of any one section could be thus granted.

2. The party applying for entry was to make affidavit before the Register or Receiver of the proper land-district as to the purpose of the entry, and must pay a fee of $10 and the prescribed commissions.

3. Upon proof that the person who has made the entry has abandoned or failed to cultivate, protect, and keep in good condition the timber, the tract was to revert to the United States.

4. Persons who have made a homestead entry, and who at the end of

the third year of residence might have had under cultivation for two years one acre of timber, in manner above designated, for each 16 acres of said homestead, might, upon due proof, receive his patent for said homestead.

5. Lands thus acquired were not to become liable for debt prior to the issuing of patent.

Forms and regulations were to be issued by the Commissioner of the General Land Office, and penalties for perjury were imposed.

This act was amended March 13, 1874, as follows:

The privilege of entry was confined to persons who were heads of families or over 21 years of age, and were citizens of the United States or had declared their intention of becoming such. The time for perfecting title was reduced to eight years. The planting might include 40 acres in a quarter-section, or 20 acres in 80, or 10 acres in 40, or a fourth part of any fractional subdivision of land less than 40 acres, but not more than a quarter-section could be entered by one person.

The person making the entry is required to break one-fourth of the area to be devoted to timber within one year from the date of entry; one-fourth part more within two years, and the remaining half within three years from the date of entry.

One-fourth part of the area to be planted must be set out in timber within two years from the date of entry; another fourth within three years, and the remaining half within four years. The same provisions with respect to spaces between trees and their cultivation and protection, that were embraced in the original act, are contained in the act as amended, except as to the time for maintenance before the issue of a patent.

In case of the death of the person before the full amount is planted, his heirs are to have the option of completing his undertaking or of receiving a patent for a part upon relinquishing their claim to the remainder. No patent is to be issued sooner than eight years after entry, and proofs of compliance with the terms of the law are required. Upon proof of neglect or abandonment, the land becomes liable to homestead entry or entry under the provisions of the timber-culture act, but not until the original claimant has been notified and opportunity given for defense.

The provision relating to planting by those who had already located a homestead were continued, as also the exemption from debt before issuing of patent. The Register and Receiver of the district land-office are entitled each to receive $2 at the time of entry and the like sum when the patent is issued. Those who had already made entries, were allowed the benefit of this act upon complying with its terms.

The timber-culture act of 1874 was further amended May 20, 1876, by adding a proviso:

That whenever a party holding a claim under the provisions of this act, or whenever making final proof under the same, shall prove by two good and credible witnesses that the trees planted and growing on said claim were destroyed by grasshoppers during any one or more years while holding said claim, said year or years in which said trees were so destroyed shall not work any forfeiture of any of the rights or privileges conferred by this act; and the time allowed by this act in which to plant the trees and make final proof shall be extended the same number of years as the trees planted on the said claim were destroyed in the manner specified in this section.

That the planting of seeds, nuts, or cuttings shall be considered a compliance with the provisions of the timber-culture act: *Provided*, That such seeds, nuts, or cuttings of the kind and for the purpose contemplated in the original act shall be properly and well planted, the ground properly prepared and cultivated; and in case such seeds, nuts, or cuttings should not germinate and grow, or should be destroyed by the depredations of grasshoppers, or from other inevitable accident, that the ground shall be

replanted or the vacancies filled within one year from the first planting: *Provided*, That the parties claiming the benefit of the provisions of this act shall prove, by two good and credible witnesses, that the ground was properly prepared and planted in such seeds, nuts, or cuttings, and were so destroyed by inevitable accident in such year.

That it shall not be necessary to plant trees, seeds, nuts, or cuttings in one body, provided the several bodies, not exceeding four in number, planted by measurement, aggregate the amount required and in the time required by the original and amended act.[1]

In rulings under this act, the General Land Office has in some cases excepted the Osage orange, box-elder and white willow from the classes of timber that may be planted by those seeking to acquire title by timber-culture. We are unable to see a just reason why either of these should be thus excluded, as each of them in its proper soil and climate becomes valuable. It would be difficult to find a more precious timber for wagon-making than the *Bois d'arc* (Osage orange) of Arkansas and Texas; a more serviceable tree than the box-elder on some parts of the Western plains, or a better tree for screens and wind-breaks in Northern Iowa and in Western Minnesota than the white willow. These rulings are not understood to have been general, and it is to be hoped they will not in any case be permanent.

Some care has been taken to make personal inquiries of persons who have had opportunities for observing the operation of the timber-culture act, and in addressing circulars of inquiry for statistical information upon this subject, the Registers of land districts were asked to state any suggestions of amendment which in their judgment were desirable, some of these are given on the following page. With respect to its present operation, I fully concur with Hon. Leonard B. Hodges, of Minnesota, in his statement of the defects:[2]

First. It is requiring more of the settler than he is able to accomplish. The result is, in a very large majority of cases the law is not complied with any further than to file the claim in the land-office, pay the entry-fee, and break ten acres. By this time the settler begins to realize the nature of the contract he has undertaken to execute. He now sees clearly that he is too poor to do the work as it should be done. He begins to evade the plain intent and spirit of the law, in the painful economy of time and labor he can so poorly afford to expend. Not that he wishes to defraud the government or shirk his responsibilities, but rather from an inadequate realization of what *must* be done, and a natural desire to save what he has invested and can so poorly afford to lose, leads him into such crooked practice as we see on nine-tenths of the quarter-sections held under the provisions of this act. Another defect in the law is in the extreme facility land can be held by parties who make the claim, with no serious intention of planting any trees, but simply to do a little breaking and take his chances in selling his interest in it, in the course of the two years he can hold it, for a profit. In this way, and aided by extensions of time, granted on account of destruction by grasshoppers and other unavoidable accidents, large quantities of very desirable government land is prevented from being occupied and improved by actual settlers. Thousands of acres of government lands are thus held, free of costs or taxes, and I see no difficulty in a company of ingenious operators, doing an extensive real-estate business under the workings of this act, for quite an extended and indefinite period of time. Another defect in the Congressional timber-culture act is the clause permitting the trees to be planted "not more than twelve feet apart each way."

This is a very serious defect, and of itself virtually defeats the objects and purposes of the act. Nature shows us plainly how forests are grown, and it is folly on the part of Congress to evade or repeal natural laws governing the growth of forests. Nature plants thickly, pays no regard to the permission of Congress to plant so wide of the mark as twelve feet apart each way, and succeeds. In her own way she grows more timber and better timber on ten acres than the settler can in the mode indicated by Congress on forty acres, and at a tithe of the expense. To illustrate: forty acres

---

[1] By an act approved March 3, 1877, it is provided that where crops were destroyed or seriously injured by grasshoppers in 1877, the claimant is allowed to be absent from his lands till October 1, 1878, under such regulations as might be prescribed, and if these insects reappear in 1878, a like leave is granted till October 1, 1879, without prejudice of rights.

[2] *Report of State Forestry Association*, 1877, p. 44.

planted twelve feet apart each way must be thoroughly cultivated during the growing season of each year, until the growing trees have attained such proportions as to shade and mulch the ground. It requires the constant daily labor of the settler during the growing season from May to August. The parties sought to be benefited by the act are too poor to give so large a portion of their time to the work. The "human necessity for daily bread" compels their attention to the care of growing crops, upon which existence depends. It is a notable fact that thus far the only successful and genuine cases of tree-planting under the provisions of this act that have come under my notice are those where the planter has been financially able to plant closely; say on an average of four feet apart each way.

A forest so planted, with prompt and thorough cultivation for three years, is a success. The chief cost is terminated in three years from planting; the young trees make a straight, upright, vigorous growth; they soon cover and shade the ground so thoroughly as to effectually prevent the growth of weeds or grass among the trees, and the annual mulching from the falling foliage keeps the ground moist and friable, obviating the necessity of cultivation, and promotes the "healthy growing condition" which the act of Congress very properly requires.

On the other hand, the evasions of the law are painfully conspicuous. In many instances strips of breaking three or four feet wide, parallel with each other, are either planted with tree-seeds or cuttings, so as to bring them within the distance allowed by law. The planting is usually done in the raw sod, left without care or cultivation, smothered in rank weeds and grass, and swept over by successive prairie fires. It is difficult to employ language sufficiently vigorous in denouncing such childish folly. It is as idle to expect to grow a crop of forty acres of forest-trees without first breaking every foot, then followed after the decomposition of the sod by thorough plowing and repeated harrowing, as it would be to expect to grow a paying crop of corn by digging post-holes 12 feet each way on the unbroken prairie and dropping the seed therein. A modification of the timber-culture act requiring the settler to plant not less than 2,700 trees per acre, instead of 300, and ten acres instead of forty, would accomplish the objects contemplated by the framers of the act, and in time prove an incalculable blessing to the treeless wastes of the Western and Northwestern States and Territories. * * * The law, to be available and productive of the greatest good to the people and to the country, should be so amended as to allow all who have already made claims under its provisions to be allowed to plant ten acres instead of forty; to plant not more than 4 feet apart each way, and to be planted within four years; two and a half acres the second year; two and a half the third, and five the fourth. The claimant should be compelled to report the actual condition of his timber-plantation annually to the Register of the land-office of the district in which the land is located. He should be, by the terms of the act, compelled to do his work in a thorough and workmanlike manner, to keep the ground well and thoroughly cultivated, until such time as the growth and development of the trees shall have rendered such further cultivation impracticable and unnecessary. And he should be required to fill all vacancies occurring from any cause within one year; such report to be verified by the affidavit of the claimant and also by the affidavits of two competent and disinterested witnesses, failing in which the land should be open to settlement by other parties.

It is urged in objection to such modifications of the timber-culture act, that Congress never would consent to give away sixteen acres of land for the planting of one acre of timber.

Now this objection brings up one more modification, and that is to make the provisions of the act cover every quarter section of government prairie land within the limits of what is universally recognized as the "treeless region," instead as now only every fourth quarter-section.

In a district in Kansas where numerous entries have been made, the Register remarks:

As the law now is, I think it fails to accomplish the object for which it was enacted. Under its provisions any person qualified can enter 160 acres of land and hold it two years (by breaking ten acres of prairie) for speculative purposes. If the law was so amended that no person could enter more than 40 acres (except in cases where a sixteenth subdivision of a section is fractional, and contains more than 40 and less than 80 acres), and having the same requirements with regard to planting one-fourth of the area, &c., in timber, as at present, and reducing the fees to $5 and the commissions to $2 for each entry, in my opinion the law would be much more likely to accomplish the object for which it was intended than it now is. A greater number of people would be supplied with timber, if successful in growing it, and there would be a greater *probability* of being able to comply with the provisions of the law in planting and growing the timber than at present. And, besides, settlers would not be nearly as likely to enter 40 acres for speculative purposes as 160 acres. If any of the timber-culture entries which have been made in this office are ever perfected, I think it will be almost exclusively entries containing 40 and 80 acres.

In one of the land districts of Colorado the Register suggests that the amount to be planted under the timber-culture act should be reduced one-half.

In a district in Minnesota it was suggested that the area of entries should be reduced to 40 acres, or the smallest legal subdivision, and that the restriction should be removed as to the number of entries in any one section. The person making the entry should be required to break ten acres within one year from date of entry, and to plant with trees two acres within three years, three acres within four years, and five acres within five years, the trees to be kept in a good growing condition until ten years from date of entry.

The Register of a district in Minnesota suggests the three following amendments as desirable, according to his observation:

1st. A reduction in the number of acres to be planted from one-fourth to one-eighth of the area entered, with the same number of trees thereon as is now required by the act of 1874. Experience has demonstrated that timber, to be grown successfully, should be planted closer than 12 feet apart. The reduction in the acreage to be broken and cultivated would enable the settler to make a much more thorough cultivation of his timber, resulting in a correspondingly increased growth.

2d. I would suggest a modification of the fees and commissions paid in timber-culture entries, to correspond with the fees and commissions paid for homestead entries of like area and cash valuation. There is neither justice nor equity in requiring one man to pay the same fees for the entry of 40 acres of land held at $1.25 per acre that are exacted from another who enters 160 acres of $2.50 per acre land.

3d. Allow a settler who has complied with the requirements of the law by planting the *full amount of timber*, and keeping the same in good condition for two years, to commute his entry by making cash payment therefor, if he elects to do so, instead of waiting eight years to receive his deed.

An observer living in a prairie region of Minnesota, where planting is a first necessity, remarks that the timber-culture act requires too much from the party complying with its provisions. The breaking of ten acres of tough prairie sod the first season, so that it would be fit to plant the second, then plowing another ten besides setting the first, would cost at least $1,000 to start on; and before the title was secured, much more. In the mean time he must earn food for himself and family. He thinks that five acres a year, and twenty acres to the quarter-section, is all that should be required.

A practical planter of large experience in Wisconsin suggests that a limitation should be placed upon the cultivation of trees under the timber-culture act, so that not over one-fourth or one-third should be cottonwood; the remainder being of the more valuable kinds; such as the ash, Scotch white, Austrian pitch, and red pines, sugar-maple, black walnut, European larch, black cherry, hickory, &c. The effect would be to give to the country a more valuable growth, and thus tend to greater benefits. He also suggests that on hilly and broken surfaces of the public domain the planting be restricted to *groups*, and on level land to *belts*, upon the four sides of each 160 acres; also that a row four rods wide be reserved on all section lines.

A suggestion has been made by an intelligent correspondent in Wyoming Territory, in reference to the operation of this act, that deserves attention. He remarks that in that Territory nothing will grow without irrigation, and a person cannot get water out of a creek valley without going to expenditures far beyond the means of a poor settler. He is, therefore, forced to plant the trees in the valley along the creek, where they can be irrigated. But as these valleys are generally not more than a quarter of a mile wide, and as his lot must be square, if he gets a piece of land with a valley across the middle, a part will lie on the bluffs and be worthless. By the time he gets 40 acres of trees planted on land near

the water, he has no land left for cultivation. The only relief from this would be a modification in the law, allowing the location to be made of irregular form, to suit the necessities of the case. This correspondent suggests that the area required for planting should be reduced from a quarter to an eighth, as forty acres of trees in that part of the country would require all the labor of one man during the summer to keep them alive, and adds:

I have tried twice to raise trees in this Territory, and have failed each time. If a man should get 160 acres of land for keeping even *twenty* acres of trees in a growing condition for *four* years, I would say he had paid high for his land.

The Register of one of the districts in Utah suggests, in view of the importance of tree-planting to the future welfare of the country, that it should be made imperative on every man entering public land that he plant and raise from five to ten acres of timber, as a condition-precedent to the granting of a patent.

In one of the districts of California the following statement and suggestions were made:

In this land district a very large proportion of the timber-culture entries were obviously made, not for the purpose of cultivating timber, but for the sole purpose of acquiring, for one or more years, a right to land so entered for the purposes of sheep pasture. I would suggest, first, the timber-culture affidavit should be more strict and full, requiring the entering party to swear that the entry is not made for the purpose of pasturage, and is not made for the benefit of any other person, in order to obtain pasturage. Second. The timber-culture application should *not* be an *entry* of the land; it should be merely a *declaratory statement*, giving all the rights which the law now gives, if a compliance with the law is made, but permitting any other filing or entry to be made over the timber-culture declaration, subject, of course, to the legal rights of the timber-culturist. If the timber-culture act permitted *timber-culture declarations*, instead of *timber-culture entries*, it could do no harm, and it might do much good.

Prof. E. Gale, of the Kansas Agricultural College, Manhattan, in remarking upon the timber-culture act, and especially that clause which permits the planting to be twelve feet apart, says:

The value of close planting can be realized much better after the very sad experience of 1874. There are several points that may be urged for close planting. The force of these observations will be much better appreciated when we have carefully examined the facts which can be adduced from experience. Trees should be planted closely—

1. For the mutual protection of the trees.
2. For economy in culture.
3. For immediate protection.
4. For the purpose of securing available timber.
5. For the purpose of securing early returns from our planting.

There is nothing more evident than that we should shape our plantations with reference to protection. The importance of this whole subject demands that it receive more careful consideration on the part of the planters. A very few acres of timber judiciously planted will prove of great advantage over a very large farm. Twelve acres arranged in belts will be far more desirable than forty acres in a body. The whole subject demands attention, as it is intimately associated with the highest interests of the State. It is to be seriously questioned whether the present shape of our timber act may not be such as to hinder, rather than to promote, the interests of forestry on the plains. The manner in which trees must be spread over forty acres of land will, in a vast number of cases, defeat the object aimed at. The reasons for this view are:

1. The cost of planting and cultivating forty acres of timber will be far more than the quarter-section is worth.
2. Very few of those who go to the frontier will find it in their power to support their families and comply with the conditions of the act.
3. The danger arising from these exposed or open plantations is, that all the trees are subject to suffer from the vicissitudes of our peculiar climate.
4. Trees thus planted will not serve the purpose of a forest, but virtually become an open orchard.

In an address delivered before the State Horticultural Society of Kansas, in 1875, he says:

It takes no prophet's eye to see that thousands of timber claims in Kansas will be failures, involving serious loss of time and money. Practical knowledge, to a large extent, is yet to be acquired on this question. A few facts have been collected, but very much remains to be learned in regard to what is essential to successful forest culture upon the plains. (*Transactions State Horticultural Society of Kansas*, 1875, pp. 20, 98.)

Mr. F. E. Robinson, of Clay County, Kansas, in reporting to the State Horticultural Society, in speaking of the operation of the timber-culture act, says:

I think it would be better if the law were such that one could plant the trees in belts to protect the farm and orchard. And I also think it would be a much better idea to give the privilege of planting more trees and less number of acres. For instance, say plant half the number of trees that the law now requires, and plant them in rows not over eight feet apart, and not more than four feet apart in the rows; and also let the law be such that one can plant seeds and cultivate. Walnut, maple, and box-elder seeds and cottonwood cuttings can be procured in almost any locality. If the law were such, I think it would prove more beneficial, for one could then plant the seeds and cuttings in drills, and cultivate them much better, and the second season thin out the rows and transplant. When they get to be six or eight years old, they would shade the ground, and keep it loose and moist. As it is, when a tree becomes six or eight years old, one cannot plow close to it without injuring its roots. Here, unless the ground is thoroughly cultivated every year, it grows very rank with weeds, and the ground bakes or packs as hard as a plank floor, thereby making it impossible for a tree to grow or even live. (*Transactions of Kansas State Horticultural Society*, 1876, p. 125.)

It is desirable to change the timber act of Congress so as to encourage the planting of trees in rows or narrow belts for the protection of the whole farm. (*E. Topping*, Ottawa, Kans., *ib.*, p. 138.)

A change in this act is undoubtedly desirable, so as to allow the claimant the privilege of planting in groves, screens, and belts, for the protection of orchards and fields. (*J. N. Hall*, Oskaloosa, Kans., *ib.*, p. 141.)

Many claims have been taken under the timber act; but very few, if any, will comply with the law. I do not think any change in the law would redound to the advantage of the settler or the State, as the settlers would not comply with the change that might be made, any more than they do with the law as it now stands. They do not comply with the homestead law in its true spirit, and hardly with the letter. (*L. M. Hill*, Hill Spring, Kans., *ib.*, p. 152.)

There are probably over four hundred claims under the timber act in this county, and the number is daily increasing. The result has been very encouraging, when properly managed. Not more than thirty per cent. of the claimants will comply with the law. If the act could be changed so as to allow the planting to be made in belts of five to ten rods wide, composed of rows not more than six feet apart, they would protect each other, and save much labor; besides, this would place a check on speculation in claims. (*C. C. Chevalier*, Garfield, Pawnee County, Kansas, *ib.*, p. 158.)

A great many claims have been taken under the timber act, but not more than one-half will comply with the laws. (*T. A. Mosher*, Belleville, Kans., *Ib.* 158.)

A considerable number of claims have been taken under the timber act. Comparatively a small proportion of them are being successfully managed. The few that have made a success of forestry have at least proved the practicability of timber culture. They have proven that it is not only practicable, but profitable. If this act could be so changed as to enable persons to plant their timber in belts for protection, it certainly would be of some advantage to the rest of the ground, but it would be better for the timber to have it in a solid body, and it would be less expensive to protect from fire to have it compact. The careful protection of timber for five or six years after it is planted will be no small item; and those who cultivate timber should have an eye to this fact in planting it. (*J. B. Schlichter*, Sterling, Kans., *Ib.* 159.)

The Register of a land office in Nevada, says:

I would repeal that clause which requires any particular part of the land to be devoted exclusively to timber culture, and advise for Nevada, Utah, Idaho, Montana, Arizona, New Mexico, and the arid parts of Oregon and California, that tree-planting be made an incident to irrigation, and one that, with small cost, may aid in the economical use of water, and tend to make permanent the various systems of ditches that are now often but temporary. This may be done by planting along the course of each irrigating ditch. Let the act be amended by substituting a proper *number of trees*,

instead of *acres*, to be planted here and there at the option of the planter applying for the grant. They would generally be planted on the banks of the ditch, and their shade would keep the water from direct exposure to the sun, thus saving as much or more than they would use. They would add to the pleasant aspect of the country, and benefit in other ways than in the growth of wood.

Soon after the passage of the timber-act nearly all of the land open for entry, was entered as timber-claims. I sincerely believe a majority of them were for speculative purposes, simply to have an excuse to hold the land for two or three years, and then sell out for one or two hundred dollars to some new comer seeking a homestead. A large number of the timber-claims in this county have fizzled out in just this way. None of those still holding claims under the timber act have fully complied with the requirements of the law. This may be deemed a sweeping assertion, but it is, nevertheless, true. Claims are being contested nearly every week at the land-office at Salina, and the same is being done at the offices in Concordia and Kirwin. In all that pertains to general knowledge the average American mind is highly intelligent, but I am compelled to confess, after close observation, that mind is profoundly ignorant of the first principles of arboriculture.

The timber-act * * * will never be the means of dotting our plains all over with beautiful groves, to give beauty to the landscape or afford a shelter from the cold, biting, impatient blasts of the Northwest. *Planting trees* 12 *feet by* 12 will never form a forest. (*T. W. Robson*, Cheever, Dickinson County, Kans.; State Hort. Report, 1876, p. 132.)

Having briefly stated the provisions of the timber-culture act and its amendments, with the opinions of some persons who have had good opportunities for observing its operation, we will notice the results so far as known.

In Alabama, Florida, Louisiana, and Mississippi, having 8 land districts, and in Michigan, Missouri, and Wisconsin, having 15 land districts, no entries have been made. The same may be said of 3 districts in Arkansas, 3 in California, 2 in Colorado, 1 in Idaho, 4 in Minnesota, 1 in Montana, 3 in Nevada, 1 in New Mexico, 3 in Oregon, 2 in Washington, and 1 in Wyoming; in all, 47 land districts. In Texas the public lands were released to the State upon its annexation, and of course this act does not apply.

In short, experience has shown that while in some sections a considerable amount of timber has been planted in good faith, and with a fair prospect of its being continued to the extent and in the manner prescribed by law, in other sections, and in a great number of cases, it has failed to answer the intentions, and has been made an opportunity for fraudulent practices, which the Registers of the land-offices within whose districts the entries are made, have no power to prevent, when there is every reason to believe that the intention at time of making them is to evade their provisions and secure some unlawful advantage.

Opinions very generally agree as to error in the clause allowing a space of twelve feet between trees at first planting. In fact this open spacing appears to be in opposition to sound principles in sylviculture, and is to be regretted, because on the prairies, and on the great western plains, where planting is most needed, the drying winds, that prevail at certain seasons, cannot well be endured by trees unless so closely set as to shelter one another from the earliest period. Such plantations would of course require thinning, from time to time, as the trees became larger and needed more room.

The entries by land districts, in the prairie States and Territories, up to July 1, 1877, are shown by the following table:

Districts.	Entries.	Districts.	Entries.
Little Rock, Ark[1]	2	Topeka, Kans	19
Prescott, Ariz[2]	11	Wichita, Kans	1,105
Florence, Ariz	24	Benson, Minn[8]	714
Sacramento, Cal	3	Detroit, Minn	113
Stockton, Cal	5	Fergus Falls, Minn	193
Los Angeles, Cal[3]	5	New Ulm, Minn[9]	496
Visalia, Cal[4]	441	Redwood Falls, Minn	476
Shasta, Cal	2	Worthington, Minn	1,047
Independence, Cal	10	Bozman, Mont	3
Pueblo, Colo	12	Beatrice, Neb[10]	309
Denver, Colo[5]	86	Bloomington, Neb	1,400
Del Norte, Colo	17	Grand Island, Neb[11]	1,367
Springfield, Dak	443	Lincoln, Neb	956
Sioux Falls, Dak	1,409	Niobrara, Neb	303
Fargo, Dak	273	Norfolk, Neb	308
Yankton, Dak	520	North Platte, Neb	275
Bismark, Dak	23	Carson City, Nev[12]	2
Des Moines, Iowa	16	Santa Fé, N. Mex	7
Sioux City, Iowa	269	Dalles, Oreg	1
Boise City, Idaho	46	Oregon City, Oreg	2
Lewiston, Idaho	46	Roseburg, Oreg	36
Concordia, Kans[6]	1,221	Salt Lake City, Utah[13]	7
Hays City, Kans	282	Vancouver, Wash	6
Independence, Kans	4	Walla Walla, Wash	249
Kirwin, Kans	1,058	Cheyenne, Wyo[14]	3
Larned, Kans	985		
Salina, Kans[7]	1,625	Total	18,235

[1] 231.92 acres under act of 1873.
[2] 916.41 acres under act of 1874; 3 claims abandoned.
[3] 762.78 acres in 7 claims, September 1, 1877. Perhaps 10 acres planted. As timber land must be irrigated it will be doubtful whether the claims can be perfected. In San Francisco district, 3 claims of 217.2 acres forfeited.
[4] A letter from the register giving the record of his office to September 1, 1877, shows that under the act of 1873 14 entries were made, embracing 2,080 acres, and under the amended act of 1874, 370 entries, embracing about 57,000 acres. Of these, 192 had been canceled, and it was thought that not more than 20 would be completed. Not more than 3,000 acres had been successfully planted, and probably no attempt had been made to plant more than 6,000 acres.
[5] 320 acres in 2 claims under act of 1873, and 13,794.04 in 92 claims (September 1, 1877). It is estimated that half will forfeit.
[6] A letter from the Register shows that 173 claims (26,596.17 acres) had been entered under act of 1873, and 1,001 claims (140,159.29 acres) up to September 1, 1877, under act of 1874. Of these, 393 had been canceled, and probably many more would fail. Perhaps 5,000 acres had been planted.
[7] In this district 406 entries were made under the act of 1873, embracing 62,337.8 acres, and 1,341 under the act of 1874 (to September 1, 1877), embracing 155,928.3 acres. A very small number of these entries will be consummated, and 402 have already been canceled.
[8] A statement dated September 1, 1877, shows that 28 claims (4,490.3 acres) had been entered under the act of 1873, and 712 claims (93,369 acres) under act of 1874. Of these, 58 had been canceled. Probably 440 acres had been planted.
[9] A statement dated September 1, 1877, shows 123 claims (19,680 acres) under act of 1873, and 418 claims (56,173 acres) under act of 1874. Of these, 78 had been canceled. About 5,000 acres had been successfully planted, and it was thought that 60 per cent. would be held for completion of title.
[10] 318 on 1st of September, 1877 (33,307 acres), of which 83 claims (10,923) had been canceled. About a quarter of the claims were being planted.
[11] 338 claims (50,727 acres), under act of 1873, and 1,062 claims (155,971 acres) had been entered September 1, 1877; 113 had been canceled. About 17,500 acres successfully planted.
[12] Up to September 1, 1877, 3 entries, and since then to January 26, 1878, 3 more; in all 480 acres. It is thought that but 2 will be perfected, embracing 240 acres.
[13] Probably 4 will be held. Not more than ten acres yet planted.
[14] 370 acres entered in 3 claims.

Claims under timber-culture act, by States and Territories, in the order of greatest amount.

States and Territories.	Claims.	Per cent.	States and Territories.	Claims.	Per cent.	States and Territories.	Claims.	Per cent.
Kansas	6,299	34.54	Washington	255	1.39	Utah	7	0.04
Nebraska	4,918	26.96	Colorado	115	0.63	Montana	3	0.02
Minnesota	3,039	16.66	Idaho	92	0.50	Wyoming	3	0.02
Dakota	2,668	14.63	Oregon	39	0.21	Arkansas	2	0.01
California	466	2.59	Arizona	35	0.19	Nevada	2	0.01
Iowa	285	1.56	New Mexico	7	0.04			
						Total	18,235	100.00

The annual reports of the Commissioner of the General Land Office show that 803,945.47 acres were entered in the fiscal year 1873–'74; 464,870.16 acres in 1874–'75, and 607,984.87 in 1875–'76. The Commissioner, in a letter dated September 29, 1877, estimates that about 16 per cent. of the number had, at that time, been canceled, either for conflict, relinquishment, or abandonment. From somewhat extended personal inquiries we are led to believe that the proportion will eventually be found much larger—in many districts 50 per cent. or even more, it being evident that in many cases the claims are held merely for speculative purposes, or were entered without appreciating the task undertaken. In fact, the requirements of the law are such that a man must have some considerable means in order to fully meet the requirements, and such men can often do better with their capital of money and labor than to seek its benefits.

THE NATURE OF PROPERTY IN TIMBER LANDS.

In comparing landed property kept for the raising of timber with that devoted to the cultivation of field-crops, we shall notice this marked difference, that while the latter may be readily subjected to rules, for rental on short periods, or for tillage by a tenant who receives a fixed share of the crop for his labor, the former must always be managed directly by the owner, or by those who are paid in proportion to the time employed. It would scarcely be possible to arrange the terms under which a tenant could plant, manage, and enjoy a woodland upon shares, much less would he be expected to plant land which he did not own, and from which, he could hardly expect to derive personal benefit. The rental of lands upon "durable leases," upon a tenure requiring an annual payment, however small, has been found practically unfortunate in our country, and such quit-rents or other obligations have been almost universally superseded by conveyance in fee simple, wherever they had been imposed and whenever it was possible.

The planting of forest trees, whether for ornament or use, must therefore be almost wholly done by land-owners, or at their expense, and the business will necessarily most interest the freeholder. The tenant may be willing to pay advanced prices for the rental of lands planted with groves, hedges, and wind-breaks, and may have an interest in maintaining them while in his care, for the benefit they bring or the profit they may add by their growth. He may be willing to pay his rent in tree-planting, or may be held by contract to bestow labor upon this object; but all of these expenses must either directly or indirectly fall upon the owner, and result finally to his benefit. The tenant can scarcely be expected to voluntarily assume the expenses of planting forests, nor will he be willing to set apart his lands already available for agriculture, to this object. He might oftener be interested in clearing lands to secure a wider area for immediate use, or be tempted to pasture plantations too soon for their good, or seek to gain some other present benefit at the sacrifice of an interest not his own.

But fortunately, the easy terms upon which land can be owned in the regions where forest-planting is most needed, will enable almost every one who has the ambition to become a freeholder, to acquire an absolute title. The increasing value of growing timber renders the gaining profit of a plantation visible and real, and the certainty of enjoyment, with enhanced value by posterity, presents a motive worthy of the highest ambition.

The history of settlements everywhere begins with a class of pioneers

who frequently prove unthrifty, are often poor, and generally exposed to privations and inconveniences that disappear as roads and mills and markets become established, and the comforts of life gather around them. But sooner or later the transient class gives way to those of more stability, and it is to this class, whether original or secondary purchasers of the soil, that we must chiefly look for effectual operations in tree-planting; for this is a business that requires some surplus means, an intelligent forethought that can look beyond a present outlay, and see and afford to wait for, a larger profit arising at a distant period, and, in short, a liberal and comprehensive understanding of the true relation which forestry bears to property, and the obligations of the living age to the future.

In entering upon a new business, especially if it involves considerable outlay at the beginning, and delay in returns, every prudent man will seek to ascertain the probabilities of advantage that he, or those who may hold after him, may derive. Here we are sufficiently informed as to first cost, and from the laws of tree-growth may estimate with singular precision as to the future. But in estimating the profits of forest culture we are met at the beginning with the uncertainty of future prices. Of these we can judge only from the past, but we may fairly estimate that they will not be less than the present, and in all probability they will be greatly advanced by the time the timber planted comes to maturity for sale. This circumstance gives an assurance as strong as can be found in any business enterprise known, and much stronger than in most branches of human enterprise. It presents especial inducements as an investment, and will doubtless in future attract the attention of financiers as a safe and profitable subject for management in large estates and by associated capital, in the same manner as our transportation business and some manufactures are now conducted.

COMPARISON OF THE FOREST VEGETATION OF THE EASTERN AND WESTERN COASTS OF NORTH AMERICA, AND THE RESEMBLANCE OF THE FORMER TO THAT OF EASTERN ASIA—THE RESEMBLANCE BETWEEN THE LAKE SUPERIOR REGION AND THE ALPINE PARTS OF CENTRAL EUROPE.

It has been noticed that while there is a wide difference between the timber growth of the Atlantic and the Pacific coasts of the United States, there is a strong resemblance between the eastern coast of North America and the eastern coast of Asia, including with the latter the islands of Japan. These resemblances among trees and shrubs include identical or representative species of the genera that include the magnolias, lindens, sumacs, buckeyes, box-elder, yellow-wood, honey-locust, pear, shad-bush, dogwoods, rhododendrons, holly, persimmon, catalpa, sassafras, osage orange, planera, walnut, butternut, hazel-nut, birch, alder, yellow and white pine, hemlock, arbor-vitæ, bald cypress, and yews, besides an abundance of herbaceous genera.[1] Of these none but some representatives of the sumac, box-elder, pear, shad-bush, and dogwood appear in the flora of the Pacific coast.

A careful comparison has also been made by the late Professor Agassiz between the vegetation of the northern shores of Lake Superior and the Alpine regions of Europe, showing a close resemblance, and in a great number of instances an entire identity of species. This analogy in-

[1] This subject is very fully presented in the appendix to an address by Prof. Asa Gray before the American Association for the Advancement of Science at Dubuque, Iowa, in 1873, pp. 21 to 31.

cludes the maples, cherries, plum, shad-bush, ash, beech, hazel, birch, alder, willows, elms, and many of the pines and firs, which when specifically different are closely allied.[1]

The influences which appear to determine the distribution and character of forest growth are chiefly *temperature* and *moisture*, and these rather according to their distribution through the year, than their extreme degree, or annual amount. *Light* is another important element, and in forest growth the outside trees of a grove are seldom symmetrical, on account of the undue development of the side most exposed to the full light. The *chemical properties of the soil* have also a marked influence, but quite subordinate to these above mentioned.

It is found that the existing forest-trees of America have a close relation, and sometimes actual identity, with the fossil forms found in the Arctic region and in the Tertiary formations of Europe. This is observed with respect to the two redwoods of California, the bald cypress of the Atlantic region, the hickories, and many other kinds. This has led to the conjecture that the vegetation of the eastern borders of the two continents is in part due to the more ancient character of their geological formations.[2] Besides being "old-fashioned," the number of species of native American trees is very much greater than in Europe, as will be elsewhere more particularly noticed.

GENERAL DISTRIBUTION OF FORESTS IN THE UNITED STATES.

As a general rule, the whole region east of the Mississippi River, excepting the prairies and "openings" in the States north of the Ohio, and the "barrens" of Kentucky and Tennessee, was, when first known to Europeans, a timbered country. There were also large bodies of timber westward of the Mississippi, but as we go west we find that these become limited to the neighborhood of streams, and gradually become less, until the last fringe of willows and cottonwoods disappears, and we find a broad treeless belt extending across our domain from Mexico northward to the Arctic Ocean. The Rocky Mountain region affords a more limited range on the divides and northern slopes, and in valleys and summer-spots among them, extending irregularly along their whole course, and up to a well-marked limit known as the "timber-line," above which vegetation for all useful purposes ceases, and we find peaks always crowned with snow. Beyond this we find a region still more arid, until we approach the mountains watered by rains from the Pacific. On approaching the coast, where these rains are excessive at certain seasons, and the soil and climate are otherwise favorable, we meet with limited areas bearing a forest growth incomparable from the immense size of the trees and their extraordinary density.

Throughout the whole of our domain we find a close relation between forests and rain-fall—the native growth having been found everywhere ample where the rains were sufficient and well distributed through the year—except in places where, from known or probable causes sufficient to explain it, this growth was absent. But in speaking of "woodlands," it may be proper to remark, that there is no word in our language more

---

[1] *Lake Superior, its Physical Character, Vegetation, and Animals*, pp. 137-190.

[2] *Agassiz's Lake Superior*, p. 150. In the address of Professor Gray, already quoted, certain striking coincidences are pointed out in the widely-separated occurrence of closely-allied species, some of which are very limited and local in the places where, found. Thus, the redwoods of California, the bald cypress of the Southern Atlantic Coast, and the *Glyptostrobus* of China have strong points of resemblance. The Torreya, belonging to the yew family, is found on a very limited area in Florida, in Japan, and in Northern China, as also in California. Other examples quite as striking are cited by this author.

variable in meaning, or more liable to mislead in statistical reports, when taken as the basis of estimate for practical results or business use. In the Northern States, if applied to deciduous trees, we find it to include a mixture of various species and of all ages, with every degree of kind, density, and value. If of evergreens, there may be great uniformity of size and kind in a given district, but not comparable with others having a different soil and climate. In the South, the term, besides including densely timbered tracts, applies to thinly timbered, grassy pine barrens, and to swamps with every grade of value. In the Western and Southwestern States, it may include scattered oak openings or dense forest, as the case may be; and on the Northwest coast, the upland valleys densely crowded with a grand and lofty timber growth.

Generalizing in the most comprehensive way, the whole region east of the treeless belt, abounds in species of the hard-wood, broad-leaved, deciduous genera, which in number of kinds and of individuals, far exceeds those of the evergreen or coniferous classes. West of the treeless belt, the conifers prevail, and the forests are made up almost wholly of this family. The exceptions are relatively few, and no forests of deciduous timber-trees occur in this region in sufficient amount to form great forests by themselves.[1]

The distribution of forests is, in considerable degree, influenced by the underlying geological formations, as furnishing the soil and chemical elements upon which character the of the vegetation must depend. From the kind, distribution, and size of timber-growth, the practiced observer is enabled to judge with reasonable accuracy concerning the nature of the rock-formation under the soil, without actually seeing it exposed.[2]

---

[1] Prof. William H. Brewer, of Yale College, in an article published in Walker's Statistical Atlas, estimates the number of species of woody plants in the United States at 800. Of these, upward of 300 indigenous species attain the height of 30 feet, of which 250 are abundant somewhere, or at least, not rare. In this he excluded all smaller trees that never attain a height of 50 feet, and the tropical species found on the extreme southern border. Of large trees somewhat abundant, he estimates 120 species, of which 20 grow 100 feet; twelve, 200, and perhaps five or six, 300 feet in height or upward. Of these 120, about fifty belong to the coniferæ. Only a very few species occur across the whole country, from the Atlantic to the Pacific. Of these, the aspen (*Populus tremuloides*) and some of the cottonwoods are mentioned; but as a rule, there is a marked contrast between the forest regions east and west of the treeless belt, the timber of the Rocky Mountains belonging to the western rather than the eastern type. New England, originally all wooded, has 80 to 85 species, of which about 60 grow to a height of 50 feet. The Middle States, also originally wooded, have 100 to 105 species, of which 65 to 67 sometimes reach a height of 50 feet. The southeastern part, also entirely wooded, has over 130 species, 75 of which grow 50 feet or more, and perhaps a dozen, 100 feet. The southwestern region was characterized by dense forests and open plains, and numbers 112 to 118 species, of which 60 to 65 grew to 50 feet. The northwestern region is diversified by prairies, "openings," forest, (some of great extent and density), and timber belts along the rivers and streams. It contains 105 to 110 species, about 68 to 70 of which grow to 50 feet.

[2] Professor Newberry, in his Geological Survey of Ohio (i. 528), notices several instances of this relation between rock formations and timber-growth. The Cuyahoga shales, rich in potash, bear a growth of large elms, scattered over this plateau as far as the eye can reach; beech and maples, with thick groves of chestnut where the broken rock comes near the surface, mark the horizon of the conglomerate, and above this a belt of forests, in which the predominate timber is oak, defines with great accuracy the limits of the coal-measures in the northern part of Ohio. The redwood of California is limited to a peculiar sandstone formation, and the noble red cedars of Tennessee to the Glade Limestone, a subdivision of the Trenton Group, which extends superficially as a very irregular ring across the central part of the State. On subsequent pages we shall have frequent occasion to notice this dependence of forest growth upon the underlying geological formations, including, of course, the soils resulting from their decomposition. These peculiarities, when understood, afford valuable indications that may be followed with profit in attempting the cultivation of timber trees.

SOWING AND PLANTING.

We shall endeavor to present in the following pages, such practical statement of methods and results of experience as appeared best calculated to afford subjects of thought and suggestions for experiment in tree-planting. The results obtained in one country may be different from those in another, but due allowance being made for circumstances, the principles of vegetable growth are everywhere alike, and a careful result of experience and observation acquires a permanent value.

SHOULD WE SOW OR PLANT?—EXPERIENCE OF EUROPEAN FORESTERS.[1]

Most foresters nowadays resort to *planting* in preference to *sowing* in beginning new forests. Is this a fashion and mere caprice, or is it the fruit of experience and observation? This question we will proceed to examine. Let us go back a hundred years or more. In 1756, the most distinguished German forester of that period, Johann Gottlieb Beckmann, published a work entitled *Experiments and Experiences upon the necessity of sowing Forest Trees.* In this work he specified the method of *sowing* as alone capable of yielding good results, and as the proper means for regenerating a ruined forest. "What shall be said of the method of planting?" he asks; and to this the reply is short and decisive, "It is not a good way, and as to resinous species, it is impracticable."[2]

Had foresters been satisfied with this positive declaration, there would have been no question as to planting within the last hundred years. But this has not happened, and they have been compelled to have recourse to planting oftener than they wished, perhaps as they regarded it, to complete and replace their sowing. They were led to observe that the ancient process of planting left much to be desired, and that it was susceptible of great improvement, while, on the other hand, they found many soils to be covered in which sowing afforded but slender chance of success. Little by little they gave more attention to the system of planting, and had oftener recourse to this method, so that fifty years after the publication of Beckmann's book, to wit, in 1805, Burgsdorf thus expressed himself in his Treatise upon Forests, in the chapter upon forest plantations: "Besides the kinds above mentioned that may be planted on a large scale, it is a principle that others may be planted, but only on a small scale; in all cases depending upon success only where the conditions are favorable." He seems to have understood these "certain rules," and "favorable conditions," and explained them; but in this it was a sad thing for sylviculture, that they tainted the precepts of the master.

It would require much time to do full justice to the system of plantation, and in proof of this the elder Cotta some twenty-five years ago remarked: "As the establishment of forest-growths on a large scale is easier to do by sowing than by planting, &c., * * * we deem it convenient to give preference to the former of these methods." An examination of the modifications wrought both in theory and practice since these principles were laid down would lead us much too far, and, in our day, progress is more rapid, and science travels further in twenty years than formerly in a century. We will only remark, that the old rule which prescribed *that we should plant only where there is no chance of success by sowing*, has now in many countries, and especially in Saxony, given place to this, *never*

---

[1] Translated from an article by the Baron Manteuffel, grand master of forests in Saxony. *Revue des Eaux et Forêts,* i, 147.

[2] Chapter iv, § 13.

to sow except where it is impossible to plant.[1] In other words, planting is now the rule—sowing, the exception; just the reverse of what it formerly was. Experience has, in fact, demonstrated to the present generation of sylviculturists, that generally a forest growth can be established *sooner*, *more surely*, and in *better condition*, by planting; sooner, because it starts at least two years earlier than one that is sown, and, furthermore, four or five years often elapse before it is positively known whether a sowing is to be repaired or completed, while in plantations the very next year will show every plant that is unable to survive, and these can be at once replaced:—more surely and in better condition, because plantations are exposed to fewer casualties than seedling growths. The success of the latter depends in the first instance, upon the quality of the seeds. Now, as we are seldom so situated that we can harvest them ourselves, we must take them as offered in the market, at which are too often sold seeds gathered before they are ripe, or that are withered, or badly kept, or heated, or too old. But assuming the most favorable conditions, let us suppose that all the seeds we get are good, we still have cause to fear that the soil is not well prepared, the sowing not even, that the seed is covered too little or too much, or that too violent showers or persistent drought, too burning a sun, or a late frost may happen to destroy all our hopes; but we will further suppose that the season has been as favorable for the coming up of the seeds as we could desire, and that the birds and the mice have scrupulously respected the tender plants, we shall be very much deceived if we suppose that everything is now secure; but in fact, if the conditions have been propitious for the growth of forest seeds, they have been equally so for the growth of pernicious weeds; so much so indeed, that we can scarcely find the little germs in the midst of the grass and herbage by which they are covered and stifled. We may sometimes pull up these weeds, but at the risk of drawing up the young plants, but this does not always happen, and in this case the mice often find among the dried weeds under the snow, a refuge, the more attractive because it offers a shelter from the cold, and young plants at hand for food. When the spring comes to melt the snow, there is more sowing to be done, for everything is eaten up. If we succeed in keeping a sowing clean of weeds the first year, we have every reason to apprehend that in the next spring following we shall find the ground spread over with young plants that have been thrown out by the frost. Many other dangers await the seedling forest during the following years, but it would be needless to enumerate them. We have said enough to show that success in sowing is uncertain.

Plantations are likewise liable to late frosts, the teeth of mice, and of various other accidents, but their existence is not endangered. In most cases these troubles do not occur after two or three, or at most, four years. The only real enemies to plantations are insects and their larvæ, and it is not surprising that foresters now give preference to this system.

Plantations become cheaper than seeding. Experienced foresters do not need facts to convince them upon this point. They know, in fact, that if the cost of first establishment is a little less in sowing than in planting, especially if seeds are cheap, the expenses occasioned in caring for the work and of replanting gaps and vacant places is much greater for

[1] Messrs. Lorentz & Parade remark: "Sowing is considered by many foresters as principally applicable to large operations because its processes are more natural and simple, as well as cheaper than those of planting. But practice tends every day to establish the superiority of the latter." (*Cours Elementaire de Culture des Bois,* 4th ed., p. 509.)

seeding, so that taking everything into account, the advantage is altogether on the side of planting. Be it far from us, however, to think, that we should never have recourse to direct seeding. In sylviculture there are no absolute and universal rules. Thus, for example, we would never advise planting timber on the light sands of La Manche or Basse-Lusace, as we would always blame sowing on the strong-sodded but thin soils of Saxony. All we have to say as to this is, that as a general rule, and except in certain well-defined cases, such as those above mentioned, *planting should be the rule; sowing, the exception.*

THE CONDITIONS MOST FAVORABLE FOR GROWING OF FOREST-SEEDS.

That seeds may germinate, they must have a certain amount of contact with the air, and a proper degree of warmth and moisture. In the natural process of seeding but a very small number of the seeds so bountifully produced, ever find these due proportions of congenial influences so as to take root and grow. It is only here and there that a seed gets lodged among the dead leaves and the mosses or gets covered by the detritus, so as to secure the needed protection and a successful growth. If seeds are left too lightly covered they may be eaten by birds, or washed out by rains. If too deep, the young shoot will be entirely smothered, or will come slowly to the surface in too feeble condition for vigorous growth.

With the view of determining fixed rules from careful trial, a series of observations was made by Dr. Baur, director of the experimental station for forestal researches at Hohenheim, in Würtemberg, in 1873, 1874, and 1875, the principal results of which are given in the *Revue des Eaux et Forêts* for June, 1876. The soil selected for these experiments was of average density. We can only state the general results:

Beech.—Seeds should be but slightly covered. The best results were found when the covering was from 0.39 to 1.57 inches, and the best depth 0.79. This agrees quite nearly with the rule laid down by Burckhard, Heyer, and Lorentz and Parade.

Quercus pedunculata.—The acorns should be planted shallow, but a little deeper than beech-nuts. The depth should be more in light soils. Heyer recommends 1 to 2 inches, and advises that they be sometimes covered by a plow.

Acer campestre (English maple).—The seeds should be but slightly covered, but a little deeper than with beech. From 0.39 to 0.78 is unquestionably best, and beyond 2.75 inches they will not grow. The observer noticed the following appearances in the germination of the maple: They issue with very long cotyledons, and if deeply covered, or if the surface of the soil is too hard, these cannot easily break through the obstacle, yet continue to grow, and at length break, and thus the germ is lost. We may thus see why many vacant places often occur in seed-beds of the maple.

Acacia.—The results here observed were quite interesting, and agreed perfectly in the two years observed. When Stumpf (*Waldbau*, 2d ed., p. 276) laid down the general rule that "large and heavy seeds should be more deeply covered," he should have excepted this kind. The results tend to show that depth has but very little influence, but that these seeds, however light, should be planted at least as deep as acorns. The result appears to lead to the conclusion that the acacia might be used with advantage in planting arid soils and southern slopes, where seeds thinly covered would scarcely grow from want of moisture.

Black alder.—This should be but very slightly covered, a third of an inch being enough. Burckhard advises that it should be very slightly covered, or even simply strewn upon the surface, and Heyer remarks that it should be mingled with the most superficial parts of the soil. The experiments of Dr. Baur gave the best results at 0.39 inch. From 0.59 to 0.98 the shoots were but few, and from greater depths but one seed came up.

Common pine.—The results of two years showed that a covering of 0.39 to 0.59 inch is the most advantageous. At greater depths the plants were scattered, and none grew from a depth of over 1.18 inches.

Fir.—With this, as with the pine, the deeper seeds were slower in coming to the surface, and the general average for best results was the same.

Silver-fir.—The best depth ranges between 0.39 and 0.77 inch, or a little more than in the case of the pine and fir. None appeared which had been covered 1.18 or more inches.

GATHERING OF SEEDS.

It is a universal law in nature, that certain qualities of excellence or defect, tend to transmission from parent to offspring. By virtue of this, the various choice breeds of domestic animals have been originated and improved. Our plants cultivated for culinary use, and ornamental planting, have thus been multiplied in variety without number, and in quality so greatly improved upon the native original, as scarcely to be recognized as of the same species.

May we not from analogy hope an equally good result in the growth and quality of timber, and of the fruits and other products of forest-trees? Herein, although we have the disadvantage of a slow growth, and a life that often outlives a man's, we have the decided advantage of being able to hold and keep what we get, by the processes of budding and grafting, as we constantly see in our nurseries of ornamental trees, where striking peculiarities, often originating in nature, or from some accidental circumstance, are perpetuated and multiplied without limit.

But starting with the seed, it is obviously of first importance that it be of the best quality;—not the first that falls, because as in fruits, it may have ripened prematurely from injuries done by insects;—not from stinted and dwarfish trees, which sometimes bear seed in morbid excess, nor from trees enfeebled by extreme age or other debilitating causes.

It is laid down as a rule worthy of close observance, that the trees from which the best seed are to be expected should be middle-aged, that grow isolated, or at least a little separate from others, so as to have the full benefit of the air and light—that the tree have a full head, and a perfectly healthy and vigorous condition.

Wood that is aged and decaying, as well as that which is young and tender, is apt to yield seed that will not grow, or at least that will produce dwarfish and worthless shoots.

Scrubby and malformed trees, are said, on high authority, to tend to the production of degenerate varieties, from which they will not recover to the primitive type, until they have been cultivated under better conditions, and through several generations.

Seeds should be gathered when the weather is dry, and such as are heavy, when they fall to the ground, as when beaten or shaken from the trees they sometimes fall before fully ripe. When gathered, they should be spread in thin layers in a dry airy place, at least until the dampness is evaporated. The mode of preservation differs greatly with the species, and the tendency to sprout, to rot, to heat, to perish by desiccation, or to mold, is to be counteracted according to circumstances. In some cases it is important to keep seeds from fluctuations of temperature by burying in dry sand, or covering them with litter or straw. In others it is advisable to keep them cool and slightly damp, as by placing them in a cellar.

The soft maples (*Acer dasycarpum* or silver maple, *A. rubrum* or red maple) mature their fruit in June, and their seeds should be planted at once. The sugar, Norway, sycamore, and some other maples, ripen their seeds in the fall, and they may be sown then, or be kept in a box, mixed with sand, until the following spring.

Acorns, walnuts, chestnuts, &c., should be planted as soon as they fall, to insure success; but as they are liable to destruction by squirrels and other small animals, it may be often convenient to keep them in boxes covered with sand in a cool place to prevent too much drying, through the winter, and then plant in the spring.

Elm-seeds ripen in June, and if they find congenial soil and conditions, will make good growth the first season.

Red-cedar berries should be bruised early in March, and mixed with an equal or greater bulk of wet wood-ashes. In three weeks the alkali will have cut the resinous gum, when the seeds can be washed clean from the pulp. In preparing the seed-beds, dig the ground a foot or more in depth, mix for three or four inches at the surface a liberal dressing of well-rotted leaf-mold (or wood-soil) and sharp sand. Lay off the beds four feet wide, and sow, screen, and cultivate as elsewhere described for other evergreens. They may be watered occasionally in the evening in case of drought. The shading should be removed and a mulching of leaves two inches deep put along the rows. They may be transplanted to nursery rows the second spring, and three years after the alternate rows should be taken out.[1]

ECONOMICAL MODE OF PRESERVING ACORNS IN LARGE QUANTITIES THROUGH THE WINTER.—METHOD PRACTICED IN FRANCE.

Acorns when kept over winter in large quantities, are liable to various accidents that injure or destroy their germinating power. They may become too dry; in large heaps they will heat and mold; or, if too wet, they will sprout sooner than is desired. To obviate these dangers, the following cheap mode of keeping them in large quantities has been mentioned as practiced in France, which might be equally adapted to the middle latitudes of our own country, with such modifications due to greater dryness of climate as experience would suggest:

A place is selected in a forest where the soil is sandy and dry, the surface level, or slightly inclined to the south, and the shelter of large trees low and abundant. It should be fenced in, and if liable to the drainage of water from adjacent grounds, a small ditch may be dug around it. The acorns are spread on the ground as gathered, but nowhere more than four or five inches deep, the leaves and litter being first removed. From the beginning, they should be raked an hour or two daily, with great regularity, during the first month, and after that a raking once in two or three days will be sufficient. By the end of December their tendency to heat will be over, and during very cold weather they should be lightly covered with leaves or ferns; but these should be taken off early to prevent sprouting. In temperate climates, no covering is needed but the shelter of the trees. In very rainy winters, the raking may be renewed from time to time, and continued till time for planting.

TREE-SEEDS—METHODS OF PLANTING.

In a report of a committee upon forestry, made to the Iowa State Horticultural Society in 1875 (p. 298), by Prof. Henry H. McAfee, the following practical statements are made upon this subject:

> Seeds may be classified for purposes of treatment into three sorts, viz, nuts, hard seeds, and soft seeds. The nuts should always be planted where they are to remain permanently, as the nut-trees do not usually transplant without considerable injury,

[1] S. Edwards, of Lamoile, Ill., in *Transactions of Wisconsin Agricultural Society*, 1858–1859, p. 506. In this article, preference is given to the red cedar in Illinois before any other evergreen for ordinary screens of moderate height. For screens to orchards, buildings, and stock-yards, the Norway spruce would do better. Mr. Edwards has tried and rejected as not hardy, the cedar of Lebanon, Deodar cedar, Mount Atlas cedar, Douglas spruce, Menzies spruce, Araucarian pine, English and Irish yews, Chinese arbor-vitæ, and golden-leaved yew. The sea-pine and European silver-fir were not sufficiently hardy unless protected in winter.

and the nuts must be kept damp from the time when they are ripe till planted; at least the kernel must not be allowed to become dry, or they will surely fail to grow. Thin soft-shelled nuts, like the chestnut, will, if exposed to sun and air, dry in a few hours enough to prevent growth. So nuts must be kept in earth, or on the earth under mulch, or in something that will prevent drying till used. Peat, moss, old straw, dust, &c., will do. A very good way is to spread them in a thin layer upon the ground, or in a trench so located that water cannot stand among them, and cover them thoroughly with mulch, planting them at corn-planting time, and about as deep as corn is planted.

The hard seeds are generally somewhat slow to germinate, and need to be in soak a long time, to be frozen wet, or to be scalded before planting, or to be treated with some substance to hasten germination. This class embraces honey-locust, which, if kept dry and planted in spring, will seldom ever grow the first year, and sometimes will not sprout till the third season; also the stones of cherries and plums, and even the seeds of apples and pears. If mixed with sand (two parts of sand to one of seed by bulk) and dampened fully, and subjected to moderate freezing through the winter, all this class except honey-locust, coffee-nut, the hawthorns, and red cedar are likely to grow the season planted. For these exceptionally hard cases water, heated to boiling, is poured over them, and, standing upon them an hour or two, some may swell, and can then be picked out and planted, and the more incorrigible treated to another scald, and thus till they all swell, or they are planted in fall and left to grow when they will; or, in case of the haws, they may be mixed into bran-mash and fed to sheep or cattle, and the droppings planted, when the seeds, softened by the digestion, are likely to grow.

The soft seeds, comprising all not named in the two other classes, may be still further divided into spring, fall, and winter seeds, each of which requires or permits different treatment. The spring seeds are those which ripen in spring or early summer, as silver and red maples and red and white elm, all ripening from May 15 to June 5,[1] and the rock-elm a little later than the others. These seeds will not keep well, and should be gathered from the trees before they fall, except where they are so situated that they may fall into still water, when, being light and floating, they may sometimes be scooped up in large quantities. As soon as possible after gathering they should be planted, not covered deeply, say one-half inch, in good mellow soil, and if a fine mulch, like damp chaff, can be obtained, it should be lightly spread over the ground to protect from too rapid drying of the ground, which sometimes takes place in June.

The winter soft seeds are ash-leaved maple, green and black ash, sycamore, basswood, &c., or those seeds which have a tendency to hang all winter in sheltered localities. These seeds may be gathered sometimes as late as planting-time and immediately planted; but if gathered earlier, had better be spread thinly upon the ground and covered till planting-time. All others of the soft or winged seeds, not classed as spring or winter, are the soft fall seeds, and they should all be stored as directed for the nuts. Hackberry and cherry, though properly classed with the hard seeds, should be freed from their pulp in fall and stored in earth to freeze, and planted in spring without scalding. All seeds, but nuts which are large enough to pick up readily, and such as may be gathered floating on still water, as noted above, are best gathered from the trees, and stored so as not to dry too much. They must not be kept in too large masses, as, so dealt with, they may heat and spoil. * * *

If ground is not very weedy, it may be economy to plant all seeds in permanent plantation; but in old or weedy ground it is generally best to grow them in seed-bed or nursery rows. If put in the permanent plantation, allowance should be made for poor seeds, and more planted than you want of trees. The question of check-row or drill-planting is to be decided by the planter, and the same reasons which determine the manner of planting corn have weight in forestry; though generally speaking, forestry is more satisfactory in drills than is an annual crop like corn. If check-rows are used, several seeds per hill are desirable; and if drills, generally twice or three times as many seeds as you need trees should go in. It is not worth while to put tree-seeds into any but mellow, moist soil, and to secure good results with them, thorough culture the first year is necessary. A rule of depth sometimes given is to cover with soil as deep as the seed is thick, and that is of course very thin for small seeds. But seeds of trees often get covered too deep, and any seeds but the nuts ought to grow with half an inch of fine earth lightly packed above the seed. Nuts may be planted a little deeper, but not very much.

Seed-beds and nursery rows are, all in all, to be advised, and they are generally used for seedling trees. Seed-beds are usually four feet wide and of any convenient length, and four inches above the surrounding level. For evergreen and larch seeds, which, by the way, ought not to be attempted by any one not trained in the nursery business, shades are used in the form of lath hurdles, with openings of less width than the

[1] These dates, and in fact the whole article, will be considered as applying to Iowa and adjacent parts in the Western prairie country.

strips, and generally in addition to the hurdles, wind-screens around the beds, while some nurserymen build arbors over their seed-beds, and such seed is generally put in broadcast, covering by sifting on sandy earth. But for any of our native tree-seeds, shading will hardly be necessary. * * *

Drills across the beds one foot apart may be planted, or drills twenty to twenty-eight inches apart may be made of any length, and on the general level, and the seeds planted at the rate of twenty to forty to the foot. Culture while plants are young should be by hand, running a hand wheel-hoe, and hand-weeding in the drill, if necessary; but when the trees have attained some growth, a steady horse may be used, and if the nursery is made of long rows, of course horse labor is better employed than if it is in short rows. Most of the native trees will be fit at one year old to remove to permanent plantation, and if to be so used, should be dug in the fall, and stored by burying, or in cellar, ready for early planting the next spring.

The writer mentions two systems of planting—the furrow and spade, giving preference to the latter, in any but a very damp spring. For this a heading spade (a sort with a long blade ending in an obtuse angle) is used to best advantage. The spade is pushed half-way down; the handle borne a foot back, and then it is pushed down the whole length, when it is again brought upright. This makes a whole proper for receiving the roots of the tree, and when set the earth is pressed down.

As for distance apart, 4 by 4 feet is generally preferable, which requires 2,722 trees per acre. Spaces 3 by 3 are as near as can be cultivated by horse-power, giving 4,840 trees per acre. The writer prefers $3\frac{1}{2}$ by $3\frac{1}{2}$, and has found that yellow cottonwood at this will cover the ground the first year.

In planting trees, the earth should not be wet, so as to make a mortar; neither should they be set while there is standing water in the hole. In such cases the soil in contact with the roots tends to become hard in drying, to the great injury of the growth. The clay that may adhere and dry on, where the roots have been puddled in transplanting, should be rinsed off before the trees are set. The necessity of pressing the earth firmly around the roots appears to be greater in the fine prairie soil of the West than where it is of a coarser texture. At least, it appears to be the concurrent testimony of planters on the prairies that the soil should be strongly compressed, leaving, however, the surface loose, so as to readily absorb the rains. A clay soil would be apt to bake if pressed. This tendency to bake is greater when planting is done in a wet time.

SHELTER TO YOUNG SHOOTS IN NURSERIES.

When the young tree begins life in its native conditions it is sheltered by the parent boughs. When we seek to produce the same kinds, in nurseries, it is in reason that we should not expose them to the direct rays of a hot sun. The careful forester will protect the tender shoots by branches of trees, lightly spread over the ground, and for this the deciduous kinds are better than evergreens, because the latter afford less shade, and sooner shed their leaves.

When this shelter is removed, it should be done little by little, to accustom the plants gradually to the open air.

NUMBER OF TREES TO THE ACRE.

Systematic treatises upon planting, give tables showing the number of trees of different species that should be allowed to remain on the ground at different ages of growth. But so many circumstances of soil, aspect, and climate affect these, that the experience of one locality can scarcely be allowed to establish rules for another. In fact, this must be left to the skill and intelligence of the planter, who should carefully observe the wants of the case and afford the relief from overcrowding that the case demands.

It has been stated, as a general rule, that full half of the trees first planted at 4 feet apart should be removed before the growth is 20 feet high; the number should not exceed 800 to the acre, when 30 feet high; and when 40 feet, not over 300 to 350 to the acre, the soil and exposure being the most favorable that are found. Others reckon the space between at one-fifth of the height.

Some idea of the capacity of soil for tree-growth, under the best management in Europe, may be formed from the statement that an acre of ash, elm, or sycamore 40 years old will contain 2,000 to 3,000 cubic feet of timber, and when 60 years old double this amount. This is, besides the successive thinnings, which become, when near a market, an important source of income, and when the growth becomes large, may be more in value than the cost of management and interest of investment. These thinnings should be continued as long as necessary, and in full-grown forests may sometimes be required in forests 80 years old. As a general rule, larch, spruce, and other conifers require less space than broad-leaved deciduous trees. Larch is supposed to do well in good soil, with 9 feet space around it.

It is also observed that certain trees bear the shade of other species better than that of their own, and that therefore a mixture, as for instance, of oak and beech, will grow nearer together than either species would if alone.

The following table shows the number of trees upon an acre, at the distance specified, and the number that might be left at different ages, with the proportional value of the thinning, taken at these several periods:

Age (years.)	Distance apart.	Trees to the acre.	Trees taken out.	Proportional value of each trimming to total trimming.
	Ft. in.			*Per cent.*
10	3 9	3,097	358	3.4
15	4 0	2,792	375	5.2
20	4 3	2,411	311	6.5
27	4 7	2,073	338	10.5
35	5 6	1,440	833	23.6
43	6 6	1,031	409	23.7
51	8 0	680	291	27.5

The amount of timber grown on a given area, in some of the governmental forests of Europe that have been planted and managed according to the rules of forestal science, is very much greater than the same soil would grow in wood if left to itself. So striking is the difference, that Dr. Berenger, who is at the head of the Italian school at Vallombrosa, remarks, in the Journal of Forestal Economy (*Giornalle di Economia Forestale*, 1871–'72:

That while an uncultivated woodland taken for a long period, and counting interest and taxes, would yield almost nothing to the capital invested, it is well established that the same land, managed according to modern science, would, in the long run, yield a revenue both conspicuous and constant.

PLANTATION OF DIFFERENT SPECIES.

Without attempting to discuss the artistic effects which become a study in landscape-gardening and the laying out of parks, we will concisely state some suggestions that have been made as worthy of attention by those who wish to apply them.

By placing a plat of white pine in the center, and surrounding it by successive belts of Norway spruce, Scotch pine, Austrian pine, white

cedar, and red cedar, the group planted on level ground, when fully grown, would appear highest in the middle, as if standing upon a mound. A belt of cottonwood around the margin would afford shelter while needed, and should be cut away when fully established.

Orchard belts of Scotch pine, white pine, Norway spruce, and larch, have been recommended, and the use of screens on the north and west sides has been mentioned as desirable. But from observation and inquiry in the prairie States of the West, we are convinced that the most injury to fruit-trees has resulted from hot, drying winds from the southwest, and that a screen against these is quite necessary.

For a mound of deciduous trees on level ground, a central plat of European larch, surrounded by belts of the American larch, soft maple, honey-locust, black oak, wild cherry, hickory, iron-wood, crab-apple, and wild plum, has been suggested. But these combinations are too variable for a general rule, and in each locality the planter, with a knowledge of the habits of growth of the trees at his command, will be able to vary them to suit his purposes.

RELATIVE VALUE OF GROWTH AT DIFFERENT AGES.

It is very often found that the layers of annual growth are thicker when young, and that they progressively diminish in width as they increase in size. The conifers of the Rocky Mountains, and elsewhere, often show this fact in a conspicuous manner.

In other kinds, as the elm, the wood is more profitable when cut young, because the timber deteriorates in quality with age. The inner wood of a large elm tree is comparatively spongy and weak. But in other woods, as the oak, the value increases in a gaining progression with age, and large timbers are worth more per cubic foot than small ones, because they can be applied to more important uses when of larger size. The annual revenue from the growth of an oak tree, of the species commonly used in ship-building, has been very carefully determined from the mean of a great number of records in France, and is stated as follows:

	Fr.	c.	
Tree 50 years old	0	10	per annum.
Tree 100 years old	0	80	per annum.
Tree 150 years old	2	00	per annum.
Tree 200 years old	4	00	per annum.

The value per cubic foot, therefore, increases with the size of the tree, and (for straight hewn timber) the length of clean trunk below the branches.

GROWTH OF WOOD IN DIFFERENT YEARS.

Every one who has closely examined the layers of wood growth on a transverse section, must have noticed that considerable difference occurs between the growth of different years. We have here, in fact, a record of the combined influences of climate upon wood growth. Soil, aspect, and other circumstances of a permanent kind may largely influence different trees of the same species, but in a given tree, one year with another, they change so little that we may scarcely be able to appreciate their effect; and in comparing the thickness and quality of the layers formed in different years, we may regard them as an indication of the effects of temperature, moisture, winds, and other variable elements of the climate.

Before trusting the conclusions to which a comparison might lead, it would be most desirable to know the laws of growth under seasons recurring with perfect regularity. We would doubtless find the layers in

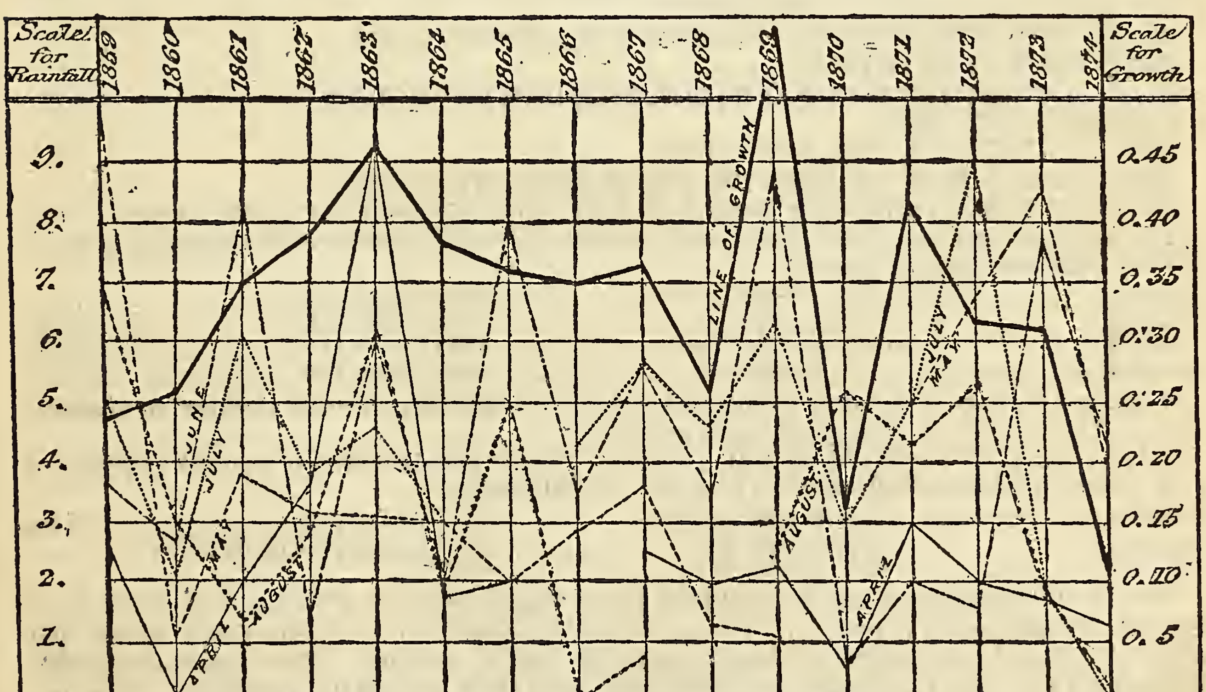
this case perfectly uniform, or steadily changing from wide to narrow, according to the laws that govern the tree-growth. But as this condition of growth is nowhere found, and might be impossible to secure artificially for experiment, we must take the averages of the whole period afforded by the section as our normal scale for comparison; and may, by careful measurement, determine approximately the character of past seasons from the growth of trees.

An attempt has been made in this study by Prof. E. Gale, of the Kansas Agricultural College, at Manhattan, the comparison being made upon cottonwood growth and the rain-fall at that place, through a period of 16 years.[1] The growth is given in hundredths of an inch in diameter. The average of the whole period, and the greatest and least, are given:

Comparison of the growth of cottonwood and the rain-fall at Manhattan, Kans.

Years.	Growth in diameter.				Annual rain-fall.	Rain-fall in the growing months.				
	Average growth.	Maximum.	Minimum.	Range.		April.	May.	June.	July.	August.
1859	.24	.30	.20	.10	36.92	2.56	9.42	3.57	4.99	6.84
1860	.26	.40	.15	.25	16.72	0.12	1.13	2.69	2.09	3.00
1861	.35	.55	.20	.35	34.56	2.00	3.76	8.20	6.08	1.39
1862	.39	.50	.25	.25	26.20	3.63	3.18	1.37	3.83	2.85
1863	.47	.65	.33	.32	39.43	9.12	3.13	5.95	4.53	6.21
1864	.38	.75	.20	.55	20.25	1.68	2.29	2.06	3.02	1.84
1865	.36	.50	.20	.30	....	2.03	2.04	7.98	....	5.04
1866	.35	.50	.20	.30	....	....	2.83	3.60	3.27	0.10
1867	.36	.65	.25	.40	26.50	2.44	3.59	5.65	5.42	0.70
1868	.26	.45	.15	.30	24.12	1.96	1.38	3.46	4.70	....
1869	.56	.80	.15	.65	28.22	2.20	1.12	8.85	6.27	2.43
1870	.16	.25	.10	.15	21.19	0.50	....	0.79	2.98	5.21
1871	.42	.65	.25	.40	28.86	3.00	5.07	2.05	5.03	4.25
1872	.32	.40	.20	.20	35.78	2.06	6.81	1.73	8.92	5.32
1873	.31	.53	.20	.33	32.89	1.67	8.54	7.78	2.84	1.64
1874	.11	.15	.10	.05	....	1.40	2.98	4.31	0.18	0.25
Mean	.33	.50	.19½	.31	28.59	2.42	3.37	4.38	4.28	3.14

The relation of quantities in the above table may be illustrated by a diagram:



Comparison of the growth of wood, and the amount of rain-fall from April to August, as observed in Kansas, from 1859 to 1874.

[1] *Transactions of Kansas State Horticultural Society*, 1874, p. 91.

In this diagram, the average growth in diameter is shown by the heavy black line, and its amount may be known by reference to the right-hand marginal scale. The mean depth of water falling in the different months, from April to August, is shown by the faint lines, and the amount is given on the left-hand scale in inches and hundredths.

The foregoing facts are not sufficient to afford a general conclusion. There appears a tendency to wide range of difference in years of great average growth, and a decided uniformity where the average growth is low. There can be little doubt but that the uniform distribution of rain through the growing months is favorable to wood growth, and that the influences of one year may be carried forward into the next.[1]

Nearly allied to differences between years in the growth of wood is the subject of seed-bearing, which, in many kinds of forest trees, comes only in certain years, at irregular intervals, and according to laws that remain till the present time unknown.[2]

PLANTING ON THE SOD.

A mode of planting is sometimes practiced in Europe, in loose and very damp soils, by simply setting the young trees upright on the surface and turning the soil up over the roots, so as to form a little conical mound: Covering with inverted sod, and, if convenient, with mosses or such other non-conducting substances as the locality may afford. This mode of planting appears to have been first described by the German forester, Henry Cotta, who, in the fifth edition of his treatise on forest culture, says:

> When the soil is very moist, we often neglect to dig holes for planting, but place the roots directly upon the place marked and bank them over with soil taken from the vicinity. This is indeed the only means of insuring success in plantations where the soil is very deep and marshy.

---

[1] Professor Gale undertook, from the rings of growth in a large cottonwood of native growth, 26 inches in diameter and 115 years old, to determine the character of the different years for the last century, for the formation of wood growth. The section was cut 24 feet from the ground, and the tree had grown in an exposed position in the valley of the Republican, 25 miles west of Manhattan, Kans.

Quite small and uniform.—1835 to 1844.

Small.—1770, 1777, 1778, 1804, 1845, 1846, 1851, 1852, 1853, 1854.

Rather small.—1855 to 1864.

Good.—1785, 1795, 1796, 1816, 1847, 1848, 1849, 1850, 1865 to 1874.

Very good.—1825, 1828.

Medium.—1797, 1798, 1826, 1830 to 1834.

Medium and uniform.—1780 to 1794, 1805 to 1815, 1817 to 1824.

Large.—1772, 1773, 1774, 1782, 1783, 1784, 1799, 1800, 1801, 1802, 1803, 1827, 1829.

The average annual growth for each decade (except 5 years in first period) was as follows (decimals of an inch):

1760–1764	0.2	1795–1804	0.12	1835–1844	0.075
1765–1774	0.135	1805–1814	0.075	1845–1854	0.09
1775–1784	0.125	1815–1824	0.095	1855–1864	0.08
1785–1794	0.1	1825–1834	0.126	1865–1874	0.1

A green ash from the same neighborhood, 120 years old, showed similar irregularities, but from 1825 to 1834 very large growth.

A hackberry, 73 years old and 21 inches in diameter, showed an annual average of 0.14 for the whole period, and by decades the following:

1805–1814	0.14	1835–1844	0.1	1865–1874	0.130
1815–1824	0.145	1845–1854	0.165	Best growth 1825–1834.	
1825–1834	0.19	1855–1864	0.145		

[2] Many observations upon this subject have been made in Europe, but without establishing any general law. In the province of Bas-Rhin, in France, the beech had bore abundantly only six or seven years in half a century. The years 1843, 1857, 1862, and 1866 were fair years, and 1822, 1828, and 1869 unusually abundant. The peculiar features of the last-named year were reported in the *Revue des Eaux et Forêts* (1870, p. 20) for future reference. The year 1877 was unusually favorable to the larch-seed in Finland.

He adds in a note:

Some plantations of Scotch pine have done remarkably that were thus executed some years ago in the forests of Tharand, under my direction, where there is occasionally found a marshy place in which the subsoil of very compact clay is covered with quite a bed of pure peat and a dense mat of moss. Here were conditions that seemed to defy planting, for drainage would dry the peat so as to render it completely sterile, and a thorough preparation would be altogether too costly for the end in view. In these cases the planting was executed as follows: The pines, 5 and 6 feet high, with considerable balls on the roots, were set directly upon the moss, and around them was heaped a little mound of moss, peat, and clay. This was done irregularly, without attempting symmetry of lines or spaces. The success exceeded all expectation until 1834, when it suffered from the winds.

From this time forward the practice was followed by Cotta's pupils in different forests of Saxony under circumstances similar to the above; but it is particularly to Mr. Grosser, chief of the cantonment of Borstendorf, that the method received careful study, and it has since come into general use where the conditions for which it is chiefly proper are found prevailing. In a single district in Germany, between 1838 and 1853, over six millions of trees were started in this manner, and with scarcely a failure. For this mode of planting it is important that the roots be spread out, and that there should be no tap-root. An abundance of spreading roots is favored in the nurseries, by covering the surface with rich manures, and by cutting off the central root at the time of first transplanting. By covering the surface between the rows of plants as soon as they are out of the ground, keeping them in place by a little soil, and watering from time to time, we secure in a great measure this end. The leaves prevent evaporation, are slow conductors of heat, hinder the growth of grass, and by gradual decay furnish the pabulum most needed by the young plant.

Surface planting is particularly adapted to the resinous species and to marshy soil. It is claimed by the Baron Manteuffel,[1] a German writer, who is the especial advocate of this mode of planting, that the fermentation and decay of the herbaceous materials so covered, furnish aliment in the form most needed by the root-fibers; that some degree of heat and moisture result from these conditions; and that, in short, the roots take hold in the soil sooner and grow more vigorously than when they are set in a shallow pit, as in the common mode of planting. A series of experiments made by Professor Stœckhardt, of Tharandt, with the view of determining the chemical and thermic conditions of this planting, resulted as follows:[2]

1. The mounds, especially in dry weather, retained for a longer time the heat absorbed by day and cooled more slowly at night than the flat surfaces adjacent.
2. The loss of moisture from daily evaporation was less from the mounds than from the sodded surface, and this difference was more marked in drought than in humid weather.
3. The amount of carbonic acid gas disengaged in the interior of the mounds was greater than that from the neighboring soil, indicating the decomposition going on within.

No appreciable amount of ammonia was observed to escape.

ADVICE OF MR. GREELEY WITH REFERENCE TO TREE-PLANTING.

The founder of the New York Tribune, took frequent occasion to urge with voice and pen the practical importance of tree-planting, not only

---

[1] *L'Art de Planter*, by le Baron H. E. de Manteuffel. Translated by *C. Goüet*, 1874, p. 7.

[2] "*L'Art de Planter*," p. 36.

for the direct, but also the indirect profits to be derived from this source. In a little manual, well known, and full of sound advice in matters relating to the general interests of husbandry, this writer gives the following suggestions as to the advantages and best methods of forest culture:

I have said that I believe in cutting trees as well as in planting them. I have not said, and do not mean to say, that I believe in cutting everything clean as you go. That was once proper; * * * it is still advisable in forest-covered regions, where the sun must be let in before crops can be grown; but in nine cases out of ten timber should be thinned or culled out rather than cut off; and for every tree taken away at least two should be planted or set out. * * * Why do not farmers infer readily and generally, that growing indifferent timber, where the best and most valued would grow as rapidly, is a stupid, costly blunder? It seems to me that whoever has attained the conviction that apple-trees should be grafted, ought to know that it is wasteful to grow red oak, beech, white maple, and alder where white oak, hickory, locust, and white pine might be grown with equal facility, in equal luxuriance, provided the right seeds were planted, and a little pains taken to keep down for a year or two the shoots spontaneously sent up by the wrong ones.

North of the Potomac and east of the Ohio, and, I presume, in limited districts elsewhere, rocky, sterile woodlands, costing $2 to $50 per acre, according to location, &c., are to-day the cheapest property to be bought in the United States, even though nothing were done with them but keep out fire and cattle and let the young trees grow as they will. Money can be more profitably and safely invested in lands covered by young timber than in anything else. The parent who would invest a few thousand for the benefit of his children or grandchildren, still young, may buy woodlands which will be worth twenty times their present cost within the next twenty years. But better even than this would it be to buy up rocky, craggy, naked hill-sides and eminences which have been pastured to death, and shutting out cattle inflexibly, scratch these over with plow, mattock, hoe, or pick, as circumstances shall dictate, plant them thickly with chestnut, walnut, hickory, white oak, and the seeds of locust and white pine. I say locust, though not yet certain that this tree must not be started in garden or nursery beds and transplanted when two or three years old, so puny and feeble is it at the outset, and so likely to be smothered under leaves or killed out by its more favored neighbors. I have experiments in progress, not yet matured, which may shed light on this point before I finish these essays.

Plant thickly, and of diverse kinds, so as to cover the ground promptly and choke out weeds and shrubs, with full purpose to thin and prune as circumstances shall dictate.

Many farmers are averse to planting timber, because they think nothing can be realized therefrom for the next twenty or thirty years, which is as long as they expect to live. But this is a grave miscalculation. Let us suppose a rocky, hilly pasture lot of ten or twenty acres, rudely scratched over as I have suggested, and thickly seeded with hickory-nuts and white-oak acorns only; within five years it will yield abundantly of hoop-poles, though the better, more promising half be left to nature, as they should be; two years later, another and larger crop of hoop-poles may be cut, still sparing the best; and thenceforth a valuable crop of timber may be taken from that land; for, if cut at the proper season, at least two thrifty sprouts will start from every stump; and so that wood will yield a clear income each year, while its best trees are steadily growing and maturing. I do not advise restriction to those two species of timber; but I insist that a young plantation of forest-trees may and should yield a clear income in every year after its fourth.

As to the far West—the plains, the parks, and the Great Basin—there is more money to be made by dotting them with groves of choice timber than by working the richest veins of the adjacent mountains. Whoever will promptly start, near a present or prospective railroad, forty acres of choice trees—hickory, white oak, locust, chestnut, and white pine—within a circuit of three hundred miles from Denver, on land which he has made or is making provision to irrigate, may begin to sell trees therefrom two years hence, and persist in selling annually henceforth for a century, at first for transplanting—very soon for a variety of uses in addition to that.

EVELYN'S MAXIM FOR THE PREPARATION FOR PLANTING.

The keeping of soil around the roots of a tree when taken up for planting, is no new notion, for Evelyn, in writing two centuries and more ago, reminds us that—

Theophrastus, in his third book, *De Causis* (cap. vii), gives us great caution in planting to preserve the roots, and especially the earth adhering to the smallest fibrils, which

should by no means be shaken off, as most of our gardeners do, to trim and quicken them, as they pretend, which is to cut them shorter; * * * and therefore Cato advises us to take care that we bind the mold about them, or transfer the roots in baskets, to preserve it from forsaking them, as now our nurserymen frequently do, by which they of late are able to furnish our grounds, avenues, and gardens in a moment with trees and other plants, which would else require many years to appear in such perfection.[1]

Evelyn also notices the importance of preparing the holes some time beforehand, so that they be left some time open to macerating rains, frosts, and sun—

So that they resolve the compacted salt (as some will have it), render the earth friable, mix and qualify it for aliment, and to be more easily drawn in and digested by the roots and analogous stomach of the tree. This, to some degree, may be artificially done by burning of straw in the newly-opened pits and drenching the mold with water, especially in overdry seasons, and by meliorating barren ground with sweet and comminuted lactations. Let, therefore, this be received as a maxim: Never to plant a fruit or forest tree where there has lately been an old decayed one taken up till the pit be well ventilated and furnished with fresh mold.

This practice of exposing the soil taken from excavations made for tree-planting to the action of frost and other atmospheric influences is sanctioned by the best experience. It is most serviceable in strong clay soils, and is chiefly limited to ornamental planting.

A PRACTICAL VIEW OF THE TIMBER-QUESTION.

We shall have elsewhere repeated occasion to mention the eminent success with which the Hon. C. E. Whiting, of Monona County, in Western Iowa, has commenced plantations of timber, and the profits already derived from this source. He has been not less diligent in precept than commendable in practice, and his experience is worthy of careful notice everywhere, and especially in the prairie States of the Northwest, to which it more particularly applies. In an essay presented at a meeting of the State Horticultural Society, in 1876, after mentioning the rapid waste and consumption of timber throughout the United States, he says:

The rapid cutting away of what forests we have, and the feeding off and plowing under of so large a portion of our prairie grass, are already beginning to tell with disastrous effect on all our inland streams, large and small. The question will here arise: What shall we do? To my mind, in the light of my experience, the answer is plain and the solution easy. Let us use the timber nature has furnished us for all the purposes that our wants really require—just as we would use a crop of wheat, corn, cattle, or hogs; but, as with the latter crops, let us consider the question of keeping up our stock. In the place of every tree we cut enough should be planted to make the loss at least doubly good.

The title-deeds which we hold to the broad acres of this good old mother earth of ours gives us no moral right to render them unfit for habitation for those who are to follow us. Nature has formed all things well, if man would only profit by her lesson, even when she made these vast prairies. One-tenth part of our surface covered with timber—planted in belts—would furnish an abundant supply for every conceivable purpose for which timber is needed. The remaining nine-tenths will furnish more of all the necessaries of life, and that with far more uniform certainty, than the whole would without the protection of the one-tenth in timber-belts. For the last twelve years for every native tree that I have appropriated to my own use I have planted at least one hundred, and it is proving to be, and is likely to continue, one of the best-paying investments ever made in Iowa. Let us now consider a few reasons why every man on a prairie farm should plant timber:

1. To those of us who have chosen our homes in this prairie State it is a binding duty that we owe to ourselves, to our State, and our children.

2. Timber-growing is no longer an experiment, but, with care, a certain and complete success.

3. The State has wisely offered to, and actually does pay, in exemption from taxation, an amount equal to the entire expense of cultivating the timber.

---

[1] *Sylva: or a Discourse of Forest Trees and the Propagation of Timber in His Majesty's Dominions, &c.* By John Evelyn (1669). Hunter's third edition, i, p. 57.

4. If planted in belts around the farm, the protection is worth more than the rent of the ground on which the timber stands. All the timber which I have planted, or will plant under the present law, will stand, when ten years old, without having cost me a cent.

5. It renders a farm so much more beautiful and attractive as a home, and so much more valuable if we ever wish to sell.

6. One can hardly look on those beautiful groves, with their cool shade in summer, and protection in winter, without a feeling of self-conscious satisfaction that he has done one good thing for himself, for his State, and for his posterity.

With these facts before us have we not every inducement to go forward in the work? Our State, as a part of the great confederacy, is taking noble lead in the work. Our State Horticultural Society is giving, and giving most earnestly, all the benefit of her great experience. The State Agricultural Society has also offered large premiums for timber-planting; but its strongest and most earnest advocates are to be found among those who, to-day, are in house, barn, and field, surround by the protecting influence of groves and belts, and know their full value both in summer and winter. A high state of civilization, and an abundance of timber, must ever go hand in hand; and it is a hopeful sign of the times, that the whole civilized world is beginning to move in this direction. Iowa, as a State, must move with the current if she maintain her present proud position. As fine groves of young cottonwood, white willows, and box-elders, as I ever saw growing I have seen in the extreme northwest counties of our State, as Clay, O'Brien, and Osceola. In the years 1873 and 1874, the Saint Paul and N. P. R. R. Company planted successfully four millions of trees west of the timber region of Minnesota, toward the Red River of the North. * * *

A few words more to one class of our citizens and I have done. To our young men who are just starting life for themselves, and feel as though they needed every dollar of money and every hour of time for other purposes, let me say, get a few cuttings of white willow, or cottonwood, from an older neighbor, or pull up a few seedlings from the nearest river-bottom, or in the proper season gather a few seeds of ash, box-elder, soft maple or elm; plant, set, or stick, as the case may be, in well-prepared ground, north and west of house and field lots; plant close together, take good care for two or three years in the way of good culture, and you will almost from the beginning have an abundance of cuttings from your own cottonwood and willows to continue your plantation around your fields, and in a very short time you will have any quantity of seeds from your box-elder, maple, and ash, for further plantations. If the quick-growing trees be planted 2 by 5 feet in the rows, an upright growth will be secured, and the needed thinning out, as the poles attain size, will very soon furnish all the fire-wood needed. Set all the trees on the outside line, in straight rows, and equal distances apart, and they will, in a very few years, support either boards or wires for a fence.

TREE-PLANTING IN EASTERN MASSACHUSETTS. OBSERVATION OF MR. GEORGE B. EMERSON, AS TO PLANTING, CULTIVATION, KINDS OF TIMBER BEST ADAPTED TO THE CLIMATE, ETC.

Mr. George B. Emerson, of Boston, in a letter commending the subject of planting in Eastern Massachusetts,[1] remarks:

In our hard and barren soil, the land on which the seed is sown, or the young trees are planted, must, for many years, be cultivated while the plants are growing, in order that they may make any show at all even in twenty years. They will doubtless grow without cultivation—but very slowly. If an open pasture or newly cleared land should be taken, the process must be very different in the two cases. In an old, open, uncultivated pasture, the soil and subsoil are usually very hard, presenting great obstacles to the penetration of the roots. In this case, the ground must be plowed, that it may be opened and loosened to the depth of two feet. After the acorns are sowed, or the trees planted, the plow can go only between the rows, leaving the subsoil between the rows unmoved. This shows the necessity of getting the ground in proper condition before the operation of sowing or planting begins.

The best kinds of oak are those of the white-oak group, viz, the common white oak, the swamp white oak, both of them common in Essex County [Massachusetts], the over-cup oak and the mossy-cup, the latter to be found in Berkshire, the stem-fruited and the sessile-fruited, which grow readily in our climate, and the chestnut-oak, found north and south of us, and the Rocky Mountain oak, found in rocky hills, in several parts of the State. The wood of all these eight is of great value as fuel and for timber uses. The next group is the red-oak group, containing the black or yellow barked

[1] *Transactions of the Agricultural Societies of Massachusetts*, 1847, p. 42.

oak, the scarlet-oak, the pin-oak, and the two varieties of the red, called the red and the gray. The black and the scarlet are common in Essex County, and are valuable and very beautiful. The pin-oak is found farther south, but would, I think, grow readily here. The red oak is a rapid grower, and a beautiful tree, but the least valuable of the oaks for fuel or timber. There is one species of the live-oak group—I mean the willow-oak, which grows so luxuriantly in the States but little south of this—that I have no doubt would grow here.

The time for sowing the acorns is in the autumn, immediately after they have fallen from the tree. It is very difficult to keep the acorns through the winter, and it is necessary only when they are to be transplanted to a distance. They should be placed just below the surface. The plants must for some years be kept free from weeds. I suppose the most profitable way of doing this is that practiced in the peach orchards in New Jersey, which are for some years covered with crops of beans, potatoes, or something else suitable to the soil.

The first acre sowed or planted as a nursery will bear plants enough for many acres of forests. As they grow larger they may be thinned out and transplanted; and when too large for that, may be gradually thinned for poles or for fuel. I suppose that, either for ornament or for timber-forest, it would be a great advantage to continue to cultivate between the trees, until they cast so deep a shade that nothing would profitably grow.

If recently cleared forest-land is to be restored to forest, plowing may be necessary, but probably not subsoil plowing, as the roots will keep the ground open and porous by their own penetration. The thing to be principally regarded is the character of the previous growth. Land ought not to be chosen which has already been covered with oaks, unless the cultivator is willing to go to the expense of trenching to the depth of two or three feet to bring to the surface unused virgin soil.

It would be well to cultivate all the different species, as different species are adapted to different situations; the swamp-oak and mossy-cup to moist land, the rock-chestnut to dry, rocky hills, the red to sandy, the white to clayey, the black and the scarlet to hard and hungry soils.

Perhaps it would be well to interpret "oaks" as including the oak family, and thus taking the beech and chestnut; the former for its beauty as a tree near dwelling-houses, the latter for its great rapidity of growth, and for its value as fencing and building stuff.

MODE OF TREE-PLANTING RECOMMENDED IN MINNESOTA.

The following is the substance of an article published by Hon. Leonard B. Hodges, of Saint Paul, relative to forest-tree planting in Minnesota:[1]

Kinds of trees to be propagated from cuttings.—Sources of supply and cost.—The white willow is most easily propagated from cuttings. The cottonwood, Lombardy poplar, box-elder, and balm of Gilead may also be propagated in this way. The cottonwood is especially valuable for prairie planting, as it grows rapidly and is hardy. The Lombardy poplar has its merits, and the box-elder, besides growing rapidly, affords a good fuel, and its sap may be used in making sugar. On the river-bottoms and on the margin of the little lakes young trees may be got in abundance. On the line of the Mississippi and Lake Superior Railroad evergreens can be got by millions. Young trees can be gathered on the river-bottoms, when the water is low in the fall, at from $1 to $3 per thousand, and the seeds of the white ash, black ash, and box-elder in the same neighborhood. Soft maple and elm seeds may be obtained on the margins of many of the prairie lakes and streams in May and June, and the ash, &c., in October. White willow cuttings must be mostly obtained from the southeastern counties of Minnesota, and may be had, securely packed in tight boxes and barrels, delivered on the cars, at $2.50 to $3 per thousand.

Mode of gathering, handling, and planting tree-seeds.—Seeds may be gathered after the first killing frosts in autumn, along the timbered streams and lakes, as also young trees of one and two years' growth in abundance. The latter should be gathered and *heeled in* by digging a trench on dry ground (where the water will not stand) and laying in the roots and half or two-thirds the length of the young tree, and then covering with earth till spring. The roots should be kept moist until planted. They should be exposed as little as possible to the sun and wind. The seeds of the ash and box-elder should be planted in the fall, just before the ground freezes, in drills, upon ground finely pulverized. These seeds usually hang on the trees till far into the winter, and

[1] *Practical Suggestions on Forest Tree Planting in Minnesota.* By Leonard B. Hodges. Published by the First Division of the Saint Paul & Pacific Railroad Company, Saint Paul, March, 1874: p. 20.

sometimes can be gathered late in the spring. The seeds of the elm and soft maple should be planted as soon after ripening as possible. The sugar-maple seeds may be gathered in October, and may be sown in autumn or mixed with sand and kept damp (not wet) in a place cool enough to prevent vegetation till spring. They may be sown in drills, and when two or three years old they can be thinned out by transplanting.

Preparation of soil and mode of planting cuttings.—The ground must be first broken and the sod thoroughly decomposed. Then plow to a depth of ten inches and harrow till finely pulverized. For a hedge a strip eight feet wide should be prepared in this way, the cuttings being set in the center of the strip, leaving a margin of four feet on each side for cultivation. In planting, stretch a small rope on the line and rake smooth under it. A man with an armful of cuttings then goes along, sticking them in *butt-end first*, and, if for a live fence or hedge, one foot apart. They should be pressed in deep, leaving not more than one or two buds out. One man can easily stretch the rope and rake the ground, and a lively lad of fifteen to twenty can stick them, at the rate of a mile a day. The cost of 5,280 cuttings is $15.85; the rest is labor.

Mode of cultivation.—As soon after planting as the weeds and grass show themselves commence hoeing *carefully*. Hoe all of the four-foot margin thoroughly, and soon afterward, when the cuttings have started so as to see the rows distinctly, pass with a horse and cultivator up and down the row often enough to kill grass and weeds and leave the margin mellow; this hoeing should be repeated several times, care being taken not to cut or injure the cuttings or young trees. After harvest, the weeds and grass should be pulled up and burned. Success depends upon thorough cultivation the first season. The second year will not require more than half the labor of the first, and at the end of the second year no further cultivation is needed, beyond a liberal mulching of manure.

Under this treatment, the cuttings in five years will have grown from 25 to 35 feet high, and from 3 to 7 inches in thickness, forming a sufficient fence against horses and cattle, and an effectual wind-break. Ten acres planted in this way, 8 feet apart, will, in five years, not only furnish all the fuel and fencing necessary to support a small farm, but will also afford some income from the fence-poles that can be spared to neighbors.

Planting should begin as soon as the frost is out of the ground, and may be continued till June. Fall plowing is preferable; and if after spring plowing, the earth should be pressed firmly down on each side of the cuttings as the planting progresses.

Estimate of the cost of planting forty acres.—In the first year, the emigrant can get settled and break up one acre for a forest-tree nursery. This should be done by the middle of June. Break the sod 2½ inches deep, and thoroughly. About the 1st of October, plow with a stirring-plow, to the depth of at least 6 inches—8 or 10 inches would be better—and then harrow. As soon as the seeds are ripened, gather those that are to be used, as ash, sugar-maple, box-elder, nuts, acorns, &c., from the woodlands that skirt the rivers and lakes, sufficient for three-fourths of the acre, leaving the remaining fourth for white willow, cottonwood, and lombardy poplar cuttings. On this acre 20,000 trees will grow and do well three or four years. Plant in drills, rows 3½ feet apart, using plenty of seed. If it comes up too thick, the thinnings may be set elsewhere. In March or April, procure cuttings of cottonwood and balm of gilead, from the river-bottoms, not less than ⅝ of an inch in thickness, and as soon as the frost is out of the ground finish the acre with these, in rows 4 feet apart, and the spaces 1 foot in the rows. They should be cultivated carefully as already described. This acre will afford trees enough to plant 40 acres, leaving a surplus. It is recommended that this acre be in the form of an L, north and west of the house and barn-yard, and at least 10 rods distant from buildings. Enough trees will be left, after planting the 40 acres, for a wind-break where most needed.

By the second year, a strip along the north and west lines, five rods wide, should be broken up, making (if a square quarter-section) almost ten acres, and when duly prepared, this may be planted the second year, or the following spring. By widening this strip every year, before the end of five years the tract will be in timbers with no other cost but labor.

PROFITS OF PLANTING.—STATEMENT OF MR. O. B. GALUSHA, OF ILLINOIS.

In a lecture at the Industrial University of Illinois, in 1869, the following instances of forest growth and profits of timber culture were mentioned by Mr. O. B. Galusha:[1]

A few miles from my residence are a few acres of ground which were cleared of timber sixteen or seventeen years since. There was then left upon the ground a growth of un-

[1] *Second Annual Report of Board of Trustees of Illinois Industrial University*, p. 352.

derbrush only, consisting of several varieties of oak, hickory, ash, and some other sorts. I have watched the growth of timber there from year to year, until the present time, and am myself surprised at the result. The land was worth, when cleared, perhaps $12 per acre, not more. There have been taken from it, during the last seven years, poles equal in value, probably, to $10 per acre, and $150 per acre would hardly buy the trees now standing upon it. So that, if we estimate the value of the land (at the time mentioned) at $12 per acre, and compute the interest upon this for 16 years at 6 per cent. compound interest, adding the amount of taxes accruing during the time, with interest upon this at the same rates, we have $100 per acre as the net profit of the timber crop; while, of course, the land itself has partaken of the generally enhanced value of surrounding real estate, and would now probably sell for $50 per acre, were the timber removed.

* * * Let us estimate the expense of raising a growth of ten acres, planted with white ash and black walnut, five acres of each. These varieties grow at about the same rate, and are about equally valuable for lumber. The seeds of the ash, like all seeds of this class which ripen in the autumn, should be gathered when ripe, and kept in the cellar through winter. The walnuts, as other nuts, should be spread evenly upon the ground, where surface water will not stand, not more than two nuts in depth, and covered with two or three inches of mellow soil, that they may freeze during the winter; to be planted as soon in spring as they show signs of sprouting. The land should be deeply ploughed, late in the fall if practicable, and finely pulverized in early spring, and marked both ways, as for corn, three feet eight inches apart. The tree-seeds and nuts should be planted eleven feet apart, which will admit of two rows of corn or potatoes between each two rows of trees. By putting two or three seeds in a place, to be thinned out to one if both or all germinate, an even stand can be secured. A better way is to plant in rows, eleven feet apart, running north and south, and three feet eight inches,—(in the marks for corn). This will secure straight trees, being closer, and they may be thinned out to eleven feet each way, when large enough to use for grape-stakes, bean or hop poles. This will give 300 trees per acre, or 3,000 trees in all, allowing for some vacancies, though in all cases of tree planting, whether in groves or screens, a supply of good plants, grown elsewhere, should always be in readiness to use in filling vacancies, which should be done at the end of the first year.

The preparation of the ten acres, at $5 per acre, would be $50. Average cost of seed, 50 cents per acre, $5. Planting, $25. The cultivation, during the first five years, will be paid for in the crops grown between rows. For cultivation from fifth to ninth years, four years, with horses only, $30 per year, $120. After this time no cultivation or care will be needed. This makes the entire cost, in seed and labor, of the 10 acres of trees, $200. These trees will, at twenty-five years of age, average sixteen inches in diameter at the ground, and about ten inches at the height of sixteen feet. This will give, deducting waste in sawing, 120 feet of lumber per tree. Allowing one-sixth for damage by the elements and loss from other causes, we have, in round numbers, 360,000 feet of lumber, which, at $50 per M, would amount to $18,000. The value of the tree-tops for fuel would be equal to the cost of preparing the logs for the mill, and the expense in sawing would not exceed $5 per M. This, added to the cost of producing the trees, and the amount deducted from the value of the lumber, leaves $16,000 for the use of ten acres of land for twenty-five years, and the interest upon the amount expended in planting and cultivating the trees! This statement may be deemed incredible, perhaps, by those who have not previously turned their attention to the subject; but after much study and many years' observation and measurements of growths of different varieties of trees, I am convinced that in all well-conducted experiments in growing artificial groves upon our large prairies, the profits will not fall far, if at all, short of the rates above stated. It must be borne in mind that trees standing at regular and proper distances upon rich prairie soil, and receiving good cultivation, will grow much faster than the same varieties found growing in natural groves. For a list of varieties suitable for planting in artificial groves, I would refer all interested to the lists recommended by our State Historical Society, with the remark that the planter can hardly be in error in planting any tree which is indigenous in a soil and climate similar to his own; while many trees, whose native homes are found in latitude north or south, have thus far proved valuable, as the osage orange and catalpa from the south and the red pine and white spruce and some others from the north. Some foreign varieties are equal or superior to any of our natives, among which are European or Scotch larch (best of all foreign deciduous trees), Austrian and Scotch pines, Norway spruce, and white willow.

SPRING OR FALL PLANTING IN NEBRASKA.

In the discussions at the winter meeting of the Nebraska State Horticultural Society, at Omaha, in January, 1873, Mr. Abbey stated that he had planted 3,000 trees in the fall of 1869, and 5,000 the following spring. A larger proportion of those were killed which were planted in the fall than those in the spring. The latter were heeled in during the winter,

and almost entirely covered with earth. He thinks the ground should be prepared in the fall and exposed to the action of the frost. He would plow deep, dig the holes in the fall, and preferred for planting two years old.

Governor Furnas had, until recently, advised spring planting entirely. but, as he has had more experience in fall planting, was becoming favorably impressed with the latter. Cuttings should always be made in the fall, that they might callous. This would be the case with the roots of the trees. Where broken they would callous and start first, before the leaves, which should always be the case. There was always more time at that season for the work.

Mr. Gregg had found that trees he had planted in the fall did well. He commenced planting early, as soon as the terminal bud was hardened, and stripped off the leaves before moving the tree. He advised root-pruning in the fall, if ever, and mulching with straw or litter.

Mr. Mason had planted 2,500 ash in the fall; did not lose 4 per cent.; favored thorough working of the ground; and procured trees of home nurseries, and planting the same day. He urged careful handling, and cautioned planters in strong terms to beware of the tree-peddler. He offered the following resolution, which was unanimously adopted:

Resolved, That the State Historical Society recommend to those planting orchards to purchase trees from the nearest nursery, and, if practicable, prepare the ground carefully in the fall, by deep ploughing, and take up trees and set them the same day.

Mr. Brewster had planted an orchard of trees from Illinois and taken special pains, but lost 60 per cent. Last spring he had set all Nebraska-grown trees, with the best of success.

Governor Saunders had best success when quick planting was adopted. As soon as a tree was dug, puddle the roots, and by that means prevent their drying.

Tree-planting in Nebraska.—Mr. J. T. Allan, then president of the Nebraska State Horticultural Society, in a report to the legislature, in 1874, estimates, from reports received, that twelve million forest and one million of fruit trees had been planted in that State in the spring of 1874. A law was much needed requiring precinct assessors to collect statistics upon this and other subjects of practical industries.

Nebraska was the first State in which an *Arbor-Day* was appointed, and the idea thus suggested has since been favorably received in Iowa, Minnesota, and elsewhere.

EVERGREEN-PLANTING IN NEBRASKA.

As to the proper season for planting evergreens, the author of an article in the Fourth Report of the Nebraska State Board of Agriculture (p. 440) remarks:

The exact time when evergreens should be moved has excited much discussion, and there is a wide difference of opinion as to the proper season. My experience, after repeated trials, is that just when the buds first begin to swell in the spring is the time; while those removed after they have grown an inch were mostly failures. While a deciduous tree, when planted, is without leaves, an evergreen has an abundance of foliage to give off evaporation. Just at the time mentioned the spongioles have commenced vigorous action; the resinous sap is thinned, and what is needed to secure a new growth is careful handling; see that the earth, which should be in close contact with the roots, is finely pulverised, and avoid by all means giving too much water. To insure the growth of any tree a certain amount of warmth in the soil is necessary. This cannot be found when the planting is done early in the spring, and in consequence the fibers lose their vitality and are unable to draw the required nourishment. Advantage should be taken of cloudy days, when both roots and tops are not exposed to the hot sun or drying winds, and, if the ground is moist, sufficient water only is needed to settle the earth about the roots, and then mulching to some distance around the tree will retain the moisture and keep down weeds.

RULES OF E. FERRAND ON EVERGREEN CULTURE (NEBRASKA).—Suggested by ten years' experience as an evergreen-tree raiser, and ten years as an evergreen-forest planter:

1st. Never plant your evergreens in the fall of the year, but do it in the spring as early as you can obtain the trees.

2d. Do not set your trees in the ground deeper by an inch than they stood in the nursery. Use no manure of any kind in planting evergreens or larch, but let the soil be mellow and friable, without lumps in contact with the roots.

3d. Do not plant trees under two years old even for stocking a nursery, and for the garden and lawn give the preference to trees one to three feet high.

4th. Never dig deep among the roots of your trees, but keep the soil mellow and moist at the surface by a light mulching of bruised straw or hay, that will prevent the weeds from growing.

5th. Last, but not least, get your trees direct from a nursery, carefully avoiding trees that are heeled in by peddlers in the fall, because such are always killed at the root, notwithstanding their green appearance; and here allow me a little digression. Give your preference to home nurseries. You have men here engaged in the business who have spent their life-time, judging what varieties of trees you could better plant, for your profit and success.—(*Fourth An. Report of Nebraska State Board of Agriculture*, 1873, p. 443.)

METHOD OF CULTIVATION BY THE WINNER OF A PRIZE.

A statement made by Hiram O. Minick, of Nemaha County, Nebraska, to whom a premium was awarded for the cultivation of a grove of not less than 1,000 trees, gives the following account of his method of cultivation:

The ground was plowed in the spring, the same as for a crop of corn, and crossed out at distances of five feet by seven. The cottonwood yearling trees were procured on a sand-bar in the Missouri River in the fall previous, and heeled in during winter. By selecting a spot on the sand-bar where the surface of the sand is but little above the water in the river, the yearling trees can be pulled out with great rapidity, probably at the rate of a thousand in twenty minutes, the operation being similar to pulling flax, and the trees can thus be taken up preserving their rootlets entire, thus securing them in the best possible condition for transplanting; and taken at this age they receive but little check in their growth by the operation. Part of my grove was planted with the spade, the operation being the same as for a hedge. Another part of the grove was planted by drawing a deep furrow with the plow, and dropping the trees at the crossings of the furrows, the roots in the furrow and the tops projecting out, and then cover by throwing another furrow-slice upon the roots and base of the stock with a plow. This left the trees leaning at an angle say of forty-five degrees, and fearing this position would be injurious to the trees, I took the pains to place some of them carefully erect; but upon an examination of the trees after one year's growth no difference was perceptible in those left leaning and those straightened up, as they invariably start their growth from a bud near the base of the stock and grow erect. The portion of my grove composed of cottonwood contains about 3,000 trees, and was the work of two men, a boy and team, one day planting. The ground was cultivated similar to corn for two years after planting. This required one hand and horse two days each year to five acres of ground. The maple portion of my grove was planted by preparing the ground the same as above, and dropping the seed (which had been procured from trees on the Nemaha River) in the furrow and covering with the harrow, and cultivating as above. The seed ripens about the middle of May, and is generally very abundant. The following may be considered as a fair estimate of the cost of the grove:

Hand and team one day procuring trees	$3 00
Two men, boy, and team employed in planting	5 00
Plowing ground	5 00
Two years' cultivation of trees	9 00
Total	$22 00

TIMBER-GROWING IN NEBRASKA.

[From an article by J. W. Davidson, in the Fourth Report of the State Board of Agriculture, p. 444.]

* * * The best method of stocking our prairies with timber is to prepare the soil precisely as you would if you were going to raise a large crop of corn. The quick-

est way to raise a grove is with cuttings of cottonwood or willow. I plow, drag, and mark the same as for corn, four feet each way, which will contain 2,722 hills to the acre. I should plant one-half to trees, four feet one way and eight the other, making 1,361 trees, and the other in corn for two years, to pay for cultivation, and that is all the cultivation needed. I should adopt the same plan in planting acorns, hickory-nuts, white and black walnuts, soft maple, elm, and ash, where the sprouts are one year old. White pine, arborvitæ, red cedar, European and American larch, when large enough to transplant, require more cultivation. I estimate the cost of preparing an acre and getting the cuttings of soft maple or ash (they can be had by the thousand along our streams) at $3 per acre. A man can plant two and a half acres per day. This is all the cost for ten years, except interest and taxes on land. I have 1,361 trees per acre; seven years from planting I will cut one-fourth, or 340 trees, equal to 15 cords of wood; the eighth year 15 cords more; the ninth the same; the tenth year you see my profits. I should cut what is left, 456 trees. Allow four trees to the cord, so as not to overestimate it. I have several trees only ten years old, which are 14 inches in diameter and 50 feet high; four, I think, would make a cord. Allowing six trees to the cord, we have 76 cords, and with 45 cords cut before, 121 cords. At $3 per cord allowing $1 for cutting, I have $242. I contend that five acres planted to cottonwood after a growth of seven years, will furnish one family with fuel for one stove a life-time and sell enough to pay for the use of the land besides. I claim, after fifteen years experience in tree-planting on this plan, which I adopted last spring on Arbor Day, on my new farm in Otoe County, Nebraska, that the white willow (*Salix alba*) is equal to soft maple for wind-breaks and fuel, and superior to all trees for rapidity of growth, as well as good for timber. Chestnut, too, is super-excellent. The climatic influence of timber is discernible in the regular attraction of rain and tempering the chilly winds of winter.

PLANTING IN NEBRASKA.

[From an article by James Morris, in the Fourth Report of the State Board of Agriculture, p. 454.]

* * * What shall we plant in Nebraska that will most quickly and fully meet our requirements? Shelter and shade are our immediate and imperative necessity. To provide these we unhesitatingly recommend, first of all, our native trees, in the following order: Soft maple, willow, cottonwood, buckeye, ash. The maple is raised from seed as easily as corn; makes a good shelter when thickly planted in rows, and a grateful shade where room is given to its lateral branches. It furnishes a fuel which, though it does not consume as slowly as oak and hickory, makes a quick, hot fire. The willow, objected to by many as a harbor for insects, yet offers a complete break to the keen winds, grows rapidly to a good size, and some varieties, as the white and the weeping willow, furnish good timber for fuel and manufacturing purposes. The common osier, planted upon wet spots, will pay as well as any other crop on the farm. Cuttings of all varieties are easily and cheaply secured. * * *

As a source of profit the raising of trees in Nebraska ranks next to the raising of stock. A quarter-section planted with chestnut, spruce, larch, maple, mammoth aspen, or even inferior trees, would, in ten years, yield a satisfactory return for the investment.

CLOSE PLANTING OF COTTONWOOD.

Judge Whiting, of Monona County, Iowa, remarked in 1869, that he had at first planted cottonwood eight feet apart each way, giving each tree 64 square feet of ground. They grew well, but too many branches in proportion to the amount of body wood. He had adopted the rule of planting three feet each way, giving nine square feet to a tree, and in this order they grew tall and straight, soon shaded the ground, and in three years needed no further cultivation than thinning as became necessary, by removing alternate rows and drawing out the poles with one horse and a chain.

THE PLANTING OF TREES ALONG HIGHWAYS.

In affirming that avenues of trees along highways add greatly to the ornament of a country, and contribute to the enjoyment of those traveling, it does not necessarily follow that they should be planted everywhere. Their known effect in reducing evaporation from the soil that they shade, doubtless tends to hinder roads from drying so rapidly after rains as they would in an open country; but damp roads are not dusty,

and here an inconvenience is in some degree balanced by a benefit. They may keep roads muddy for a time in spring, but if evergreens, they tend to keep the snows from melting in winter when sleighing is desirable. There may also be cases in which a farm is already too much shaded for the good of its crops. In short, the planter must exercise here, as in all things, a proper discretion, and balance the arguments for and against. It would probably result in planting by the wayside as a rule, in a great majority of cases—the spaces being wider apart where objections were brought on account of mud. Where this tendency exists it may be in a large degree obviated by trimming up the trunks so that the shadows will not remain long in a place, and a free circulation of the air is permitted; this will also remove much of the objections about the shading of cultivated land.

ORNAMENTAL PLANTING IN PARIS.

The number of trees in avenues in Paris, according to a statement made in 1875, is 102,154. All streets more than 26 meters wide are bordered on each side by rows of trees. If 36 meters wide, there is a double row, and if 40 meters, there is usually a plateau in the middle, with a carriage-way and sidewalk on each side. The trees are set at least 5 meters from the front of the houses, and they are 5 meters apart and 1.5 meters from the borders of the walks.

The choice of species presented some difficulties, on account of the nature of the soil, and the only kinds finally selected were the sycamore (*Platanus*) and the horse chestnut (*Æsculus*). A third kind, the Planera, was employed on the Boulevard de l'Hôpital, and promises well. The cost of maintenance is 190,000 francs per annum, including the care of plats on which the trees stand, the removing of dead trees, &c. The gardens, squares, or planted places, (besides the four great promenades of the Bois de Boulogne, the Parc des Buttes-Chaumont, the Bois de Vincennes, and the Parc de Montsouris, together amounting to 1,835 hectares,) are 74 in number, amounting to 57 hectares.

For some years past, many of the trees in Paris have been observed to shed their leaves prematurely. It was found to be due to a great number of minute insects of the genus *Ascarus*, which, appearing in May and June, gathered in great numbers on the under sides of the leaves, causing them to curl up and finally fall. So far as noticed, the *Ailanthus* appeared to be exempt. The *Tilia argentea* and *T. parmeterii* appeared to be preserved by a pubescence under the leaf. The *Æsculus rubicunda*, with its coriaceous leaves and robust habit, appears to resist the attack of the insect, and to hold its leaves till winter.

OBLIQUE PLANTING.

Among the established rules of planting are the three following:

1. Set to the same depth as the plant stood in the nursery.
2. Spread with the hand the fibers of the root in their natural direction.
3. It is essential that the plant should stand upright.

A recent writer[1] has shown that these rules have their exceptions, and, describing the usual manipulation of planting, says:

> The workman takes the plant in his left hand, holds it vertically in the middle of the hole to the proper depth, and with the right hand (not particularly caring for the direc-

[1] M. Regimbeau, in the *Revue des Eaux et Forêts*, 1875, p. 139. The above is but a condensed abstract of this article.

tion of the roots), fill in the earth around the plant, crowding it down as it fills up, and press it down with the feet. The operation thus described would be called well done, if executed carefully and without slighting. But as we turn in and press down the earth, the radicles are crowded together in a vertical direction, like the rods of an umbrella when shut, instead of being in a natural position, and more or less plants will be lost.

My plan would be as follows:

Having thown out the dirt, I would put about half of it back, so as to make a slope on one side, against which I would lay the plant, the roots being of the same depth as before being drawn. In this position it is easy with either hand to spread out the radicles, and finish by filling the hole and pressing in the earth, as commonly done. Plantations thus executed in 1859 appear now sensibly better than those in adjacent grounds, executed at the same time and in the common way. But in this case the plants were buried deeper than the rule prescribes, and to this may be due a part of the success.

In deciduous plantations it is a rule to trim the young plants more or less, so as to preserve a due balance between the roots, torn and lessened by the extraction, and the top. Resinous species should never be subjected to this operation, but they generally shed more or less of the lower leaves, which amounts to the same thing, and leave only a tuft of small branches and leaves at the top, exposed to the winds and the weight of snows, which are most liable to injury the first winter.

It therefore appears probable that a young plant would suffer less to have these lower leaves buried, than to lose them by drying in the air, and that planting a little deeper is beneficial—rules to the contrary.

On the other hand, if we plant young oaks in autumn, some vertically and others horizontally (it might not be the same in spring, and I give my own experiences), it does not appear to show any difference. It appears chiefly important that the plants be laid deep enough, while by the oblique method the roots are most easily placed somewhat in their first position.

As to expense in planting, the difference of time is from 15 to 20 per cent. in favor of the method recommended, which has moreover a decided advantage of not being so liable to damage from the heaving of frost.

I do not hesitate to recommend the burying of more of the stem than was covered before, the proportion extending to two-thirds or more.

PLANTATION OF EVERGREENS—PROFESSOR AMOS EATON'S DIRECTIONS.

Prof. Amos Eaton, in his Geological and Agricultural Survey of Rensselaer County, New York (1822), alluding to the difficulty of transplanting evergreens, attaches importance to the most careful handling and to the keeping of the roots moist by retaining the soil upon them, or covering with wet moss, cloths, &c. They succeeded best, according to his observation, when the roots were not bent or distorted in planting. They should be cut off at a distance of one or two feet from the stem, and taken up without force or without wounding the body or limbs. He laid down the rule of never cutting off a limb until at least a year after transplanting, and of never pruning evergreens at first close to the stem. He would leave four or five inches, which, after it had withered and died, might be cut close without injury to the wounded part, which should be covered with some kind of adhesive paste.

In selecting evergreens from the woods, care should be taken to obtain only those that grew in open and exposed situations, and, as nearly as might be, from a soil in composition, texture, and dryness as nearly as possible like that to which it is to be transferred.

Deciduous forest-trees required less care, excepting oak, walnut, and ash trees, which required the same treatment as evergreens.

EVERGREEN-PLANTING IN ILLINOIS AND IOWA.

Mr. Samuel Edwards, formerly of Mendota, Ill., who has had an extensive experience in planting evergreens, states his belief that the sur-

face soils of Iowa and Illinois appear to be well adapted to this class of trees.[1] He remarks:

Extensive plantings of pines and junipers may be made with perfect safety on sandy soils, and those having a thin layer of porous surface soil. But on such soils I would not advise any one to put out plants of less size than 1 foot in height; 2-foot plants would do better. Excessively dry seasons are almost certainly fatal to small plants on such soils. Puddling the roots with clay mortar is always advisable when planting out evergreens, being sure to have roots perfectly wet when placed in position for covering with dirt. In such soils, too, it is best to set deeper than the plants stood in nursery. In moist localities arbor vitæs and spruces are perfectly at home.

In the discussion of this paper the opinion was expressed that the Norway spruce was the best ornamental evergreen for Eastern Iowa. The white pine had proved healthy, but the Scotch and Austrian pines had been badly infested with a kind of aphis, which injured the trees.

In dry soils, evergreens had suffered from drought, but on porous soils they had generally been grown with success. The relatively dry air of the West, as compared with that of Europe, appeared to account for the great difference observed with respect to the locations and conditions under which evergreens will thrive. It was remarked by one who had seen planting operations in Europe that—

Wherever a larch, spruce, or pine can be started, (even with rock near to the surface,) the plants grow with a luxuriance we can *never attain* here under the most favorable conditions. The forester there goes to his work of planting coniferous seedlings with the plants wrapped up in a dry rag. He makes a hole with a tool provided for the purpose, sticks in the plant without regard to shape or position of the roots. The cavity is closed by a movement of the tool and a motion of the foot, and the work is done. Yet the plants rarely fail to grow, and that with a vigor wonderful to behold on such sterile soil.

EVERGREEN PLANTING—METHODS AND ADVICE OF MR. R. DOUGLAS.

Mr. Robert Douglas, of Waukegan, Ill., in a lecture before the Kansas State Horticultural Society, sums up the whole substance of success in transplanting evergreens in a few words: "Plant early in the spring; never allow the roots to become dry, and pack the ground tight, so that they cannot shake about or be moved by the winds." He would plant as soon as the frost is out of the ground, (first puddling the roots as soon as received), and plant a little deeper than they had grown in the nursery. The center of the hole should be elevated to set the tree on, and the roots should be spread out and filled in compactly, and particularly under the tree, so that it will not sink.

In his own practice he sowed the seeds in the spring, until May, in beds 4 feet wide, broadcast, and raked in. The young plants must be shaded, the first year at least, by lath, cloth, or brush, and his former practice was to lay frames of lath, with spaces as wide as the strips, over the seed-beds. Another, and by some regarded as a better screen, is a frame-work of poles raised upon posts about 6 feet high, and covered with brush. He would bed out the plants from 3 to 6 inches apart in the rows, and the rows 12 to 18 inches apart, shading the first season, and working with the hoe. The earth should be drawn up to the plants at the last hoeing of the season, to prevent heaving out in winter. In two years from planting they will be nice stocky trees, averaging about 1 foot in height, and may then be planted in nursery rows, 3 or 4 feet apart, or in shelter-belts and hedges. Three-year-old plants, 6 to 9 inches

[1] *Transactions of Iowa Horticultural Society* 1875, p, 124.

high, may be planted immediately into 3-foot or 4-foot rows. His advice in the choice of kinds for different situations was as follows:

For hedges and screens, not intended to grow higher than 8 feet, plant the American arbor vitæ; for higher hedges and screens, plant Norway spruce; for wind-breaks, sheltering orchards, &c., plant Scotch pine or Norway spruce.

For ornamental planting, use Norway spruce more freely than any other evergreen. I would particularly call your attention to the European or Tyrolese larch, as undoubtedly the most valuable timber-tree for extensive planting, combining the durability of the red cedar with rapidity of growth, extreme hardiness, freedom from disease, and adaptability to almost every variety of soil.[1]

EVERGREEN SEEDLINGS.—OBSERVATIONS OF H. M. THOMPSON, OF SAINT FRANCIS, WIS.

Losses have very often been experienced in transplanting evergreen seedlings, and these have often been attributed to the fact that they had been grown in the shade; but this result, Mr. Thompson thought, was not wholly due to the sudden transition from shade to sunlight, but to other causes, such as the pulling up of the plants instead of digging with a spade, imperfect packing, and exposure of the roots to the air. It is well known that shade is one of the most essential requirements of a young evergreen plant, enabling it to retain an equable volume of moisture, and preventing evaporation from the soil. In order to ascertain what would be the result of exposure to full sunlight, in the spring of 1874 he had removed the screens from several beds of one-year-old Norway seedlings and Scotch pines, and from two-year-old Austrian pines and arbor vitæs. During May and a part of June, the moisture was sufficient for a fine growth, and favorable to the development of buds and ripening of the wood. But for five successive days in July, the heat was excessive, rising from 98 to 103 degrees; the surrounding objects tended to hinder a free circulation of air, and the heat and evaporation must have been excessive.

In autumn it was found that the loss of the Norway spruce was about fifteen per cent.; arbor vitæ fifteen per cent.; Scotch pine less than half of one per cent.; Austrian pine no loss. The loss of the former of these was attributed to the fact that the lateral roots of these species of seedlings grow nearer the surface, and are, therefore, more liable to injury from heat and evaporation. In August of the same year, he transplanted 10,000 Scotch pines from the beds that had been exposed, with a loss of less than half of one per cent. In June and July, 1873, he transplanted about 30,000 Norway spruce, two to six inches in height, without loss; these transplantings being at an unusual season of the year, but in a cool, damp atmosphere, and in a wet soil after a rain, the June and July transplanted seedlings being sheltered by lath screens; the August planting of Scotch pine having no protection until nearly a month after the transplanting was completed. His practice had been for years to bed out all seedlings less than six inches in height, and protect them the first season with a cheap screen; larger sized seedlings either bedded out or planted in nursery rows and mulched; the loss from drought under this treatment being too trifling to mention. His deductions from these observations were—that nursery-grown seedlings having an ample supply of roots, if properly handled, planted, and cared for, will survive and produce satisfactory results.[2]

---

[1] *Transactions of Kansas State Horticultural Society*, 1872, p. 182. In some localities the larch, grown rapidly, has come to the size of a fine-looking tree before its wood has hardened, and such timber by no means justifies the reputation for durability here given. Our experience with this tree has not yet been sufficiently long to enable us to determine how far this valuable property in the timber will be acquired by age.

[2] *Transactions of Wisconsin State Horticultural Society*, 1875, p. 90.

ON THE PROPAGATION OF EVERGREENS—EXPERIENCE OF A SUCCESSFUL PLANTER.

Mr. Samuel Edwards, of Illinois, who has had eminent success in planting evergreens, at the University course of lectures and discussions held at Rockford, Ill., in February, 1870, made the following statements concerning the handling of evergreens:

I have had a good many years' experience with evergreens. Growing them from seed in ordinary seasons on our prairies is rather difficult. A wet season, like the last, is better; but, as a rule, those who are inexperienced had better buy their trees.

To grow evergreens, soil that is about one-third sand, with some mold, should be used. The seeds should be covered once or twice their diameter. They should be sown early to prevent their "damping off." This arises from excess of moisture in hot weather. We sow on dry sand to check it. Sow the seeds in beds four feet wide; about two pounds of the seeds of the European larch, or of the pines to the square rod. Cover the young plants with leaves the first winter. Leave the plants two years in the beds before transplanting. Birds are fond of the seeds, and must be watched. In getting trees from the forests, plant them as quickly as possible, and put a shade of laths over them. Plant them closely in the bed; leave them in the bed generally two years, and then plant the rows two and a half feet apart, but the trees close together in the rows. We sowed our seeds last year at Green Bay. The atmosphere is not so dry there; the birds are the only trouble. I prefer to plant evergreens when in a state of rest, but they can be moved in a moist day until late in the season. In that case I would plant late in the evening, water heavily, and protect them the next day from the sun. Trees for belts I place ten feet apart in the row, and break the joints with the next row.

Red cedar has generally succeeded pretty well until three or four years ago. Hemlock is grown best in partial shade. The American yew is fine in the shade. It is similar in leaf to the European, and to the hemlock. It is propagated readily from cuttings in the shade, late in May. The Norway spruce will bear shearing well; as also the arbor vitæ.

[In answer to queries.] When the branches are too thick, taking out the alternate branches often does very well. It will answer to move seedlings that have not been transplanted, if you are careful. I would just as soon have trees from the woods; but they must be carefully handled, and be small ones, not more than four to twelve inches in height. Red pine is difficult to handle. Austrian pine is attacked by a fungus. I find it here at Rockford. Siberian arbor vitæ does very well here. In the shade, it roots readily from cuttings made with a part of the last year's wood left on.[1]

Mr. Edwards, in an article published in the Iowa Agricultural Report of 1871 (page 346), explains more fully some points of his method in propagating evergreens and larches:

The beds are made four feet wide, for convenience of weeding. By sowing so early, the plants attain the woody fiber before hot weather, which is so fatal to the plants while young. The beds when sown may be covered with damp moss, rags, or something of the kind; this is to be closely watched, and removed when the plants begin to show themselves. Arbor vitæ and many varieties of juniper are readily grown from cuttings four to six inches long, taken off in May, or the fore part of June, with an inch or two of last year's wood, and planted two-thirds of their length in the ground, the lower end in pure sand. Cuttings of this kind, and of small plants of evergreens should be shaded in time of extended drought, and should receive a liberal watering every two or three weeks, followed, before the surface dries, with a mulching of dry forest leaves, sawdust, or other litter. The idea formerly so prevalent that evergreens were more difficult to transplant successfully than deciduous trees, is not sustained by extended experience. It is now generally known that the roots of evergreens must never dry in the least while out of the ground. Transplanting can be done from opening of spring until time of bursting of the buds. Even after growth of an inch has taken place, they may be successfully planted if the roots are grouted as soon as they are taken from the ground and well watered and mulched when planted. Shading the tops when late planted makes success still more certain. Early planting is always advisable. In time of severe drought large specimens, at other times nearly certain to die, may be safely transplanted if the work is carefully done and the tops are watered each evening. From the time when the terminal buds are formed until the middle of September, transplanting may be done with safety. In an extreme instance, I had good success with a lot of thirty or forty, from the forests of Colorado, planted at their

[1] *Third Report of Trustees of Illinois Industrial University*, p. 385.

arrival, just at the opening of winter, by covering with leaves so deep as almost if not entirely to exclude the frost. It has been generally supposed that late fall planting of evergreens, or taking up plants in the fall and preserving them for early spring planting or shipment, could not be done. Robert Douglas & Son, of Waukegan, Ill., however, have for two past winters kept millions of young plants in their frost-proof lighted greenery with the most perfect success. Their discovery or use of this mode is of great value, for those wanting trees sent South can thereby plant much earlier, and have them established and growing before the dry, hot weather comes on.

Immense quantities of evergreen plants will be in demand during the next few years in the prairie States. Our people thus far have only thought of planting them for ornamental trees on the lawn or for screens. But timber-culture in earnest is about to begin. European larch and the pine will doubtless be planted in immense numbers. From experience in planting larches four to six feet high in the fall, it is my opinion that we shall eventually adopt the plan of setting out our two-year and older larches at that season. If small, mulch liberally. When set in spring, they ought to be put out very early, as they start the first thing in spring. They do not thrive, unless planting is done before starting.

Many evergreens were injured by the unprecedented freeze of last October, in conjunction with the excessively wet season. This conclusion seems probable from the fact that evergreens in very dry situations were almost entirely exempt from injury. While tree planters regret losses from casualties of this kind—to the men whose hearts are in the business, such drawbacks act only as incentives to increased diligence in the good work. True manhood, it has been well said, is only developed in bravely meeting and, under God, overcoming obstacles.

MANAGEMENT OF THE PINE TRIBE.[1]

At the sixth meeting of the British Association for the Advancement of Science (1836), a paper from John Nuttall, of Tittour, county of Wicklow, was read on this subject. Having noticed that almost all the plants of *Pinus sylvestris* and other species, when planted in a light clay-slate soil, on exposed situations, grow too rapidly, or out of proportion to their rootings, and thereby become *wind-waved*, and that those which, by accident, had lost their leaders took a strong hold on the ground, he commenced a series of experiments, as follows: In the spring, when the buds were fully developed, he went over those that were suffering from the foregoing causes, and broke off all the buds except those on short branches. By this process their upward growth is checked for a year, the trunk increases in bulk, and the plant roots much more freely than if the shoots had been allowed to grow. New buds are formed during the summer, and in the following spring these plants present the most vigorous aspect.

The larch he cuts down to a strong lateral branch, on the windward side, when possible. These soon begin to spread their roots, increase in size similarly, and utimately become choice trees. In some instances he had cut them down a second time, when he found it necessary, and with equally good effect.

PLANTING OF WILD EVERGREENS IN IOWA, AS RECOMMENDED BY D. W. ADAMS.

The following suggestions upon the planting and care of evergreens, by D. W. Adams, esq., of Waukon, Iowa, is founded upon experience, and is worthy of attention:[2]

I have practiced the following method of taming wild evergreens, with perfect success: At the proper season for transplanting, proceed to the grove where the young plants are abundant, well furnished with common boot or other convenient-sized boxes, moss, pruning-knife, spades, and buckets. Make a puddle of rich earth and water; as fast as the plants are raised, prune away the dead and deformed branches, dip the roots in the puddle, and pack upright in the boxes, with damp moss among the roots, and so continue until the box is crowded as full as possible. But one tier should be

[1] *Transactions Brit. Asso. Sci.*, 1836, p. 104.
[2] *Iowa Horticultural Reports*, 1867, p. 16.

put in a box. Then nail a few slats on the top, but be sure and have plenty of ventilation, as there is great danger of their heating if the boxes are closed too tightly. As fast as the boxes are filled, place them in a cool, shady place till all are full; then load them on a wagon and lose no time in taking them to their destination, where, of course, they should be planted without delay, in accordance with the directions given for seedlings. If your plants are taken from a situation much shaded, which is not advisable, it will be well to give them a little shade during the first summer. When young evergreens are taken from the forests, it is seldom advisable to plant them at once in their permanent location. Usually they are poor, weak, straggling things, not at all ornamental. They should be taken from the wood to the nursery, where, after receiving from two to four years' careful culture, as described for seedlings, they will become of a rich dark green color, the foliage will become dense, and the form symmetrical. Then they are prepared to come out and display their charms upon the lawn, or show their usefulness and beauty in the grove or screen.

Selection of varieties in planting evergreens in Iowa.

The varieties of evergreens adapted to the climate of our State [Iowa] are not very numerous, but most of them have more or less good qualities to recommend them. Of course, before selecting his varieties, the planter will decide upon the object to be attained by the planting. If his object be shelter, he will choose strong, rapid-growing varieties, that are cheaply procured and easily transplanted. If he is growing a grove for timber, wood, or fencing, he will, of course, keep in view the particular object for which they are intended, and select accordingly; while for ornament alone, he would make a very different selection. Perhaps a word or two descriptive of some of the more valuable kinds would not be out of the way.

First on the list for general usefulness, I place the Norway spruce. It is easily transplanted, of rapid growth, fine form, and grows to a large size. It makes a very ornamental hedge or screen, is a fine single tree on the lawn, or a shelter-belt impenetrable to the wind. Scotch pine is easily transplanted, grows rapidly while young, and makes a strong, spreading tree, that always gives satisfaction to planters. I know of no evergreen that will make a shelter so quickly, and the young trees are very ornamental. Austrian or black pine is every way a much finer tree than the Scotch, except that while young, it is a slower grower, and is more impatient of removal. A large Austrian pine, clothed in its garb of rich dark green, standing up unscathed against our fiercest and coldest wintry blasts, looks the very impersonation of sturdy vigor and health. White pine has many friends, and is the most valuable of all the pines as a lumber tree. It is of rapid growth, has beautiful light green soft foliage, but is rather difficult to transplant. Red cedar is a tree of moderate growth, easily transplanted, valuable for screens, and invaluable for posts, as the wood is very durable. White cedar, or Arbor vitæ, is also useful for ornament and screens, but will not be largely planted. The native spruces, when they can be procured cheaply, are of much value, and may be extensively used in groves or otherwise. Balsam fir is probably the least valuable of all I have mentioned. While young, it is quite ornamental, and is easily transplanted, but it soon becomes shabby, is comparatively short-lived, and the wood is of very little value for any purpose whatever.

TRANSPLANTING OF LARGE EVERGREENS AND OTHER LARGE TREES, AS RECOMMENDED BY MR. D. C. SCOFIELD, OF ELGIN, ILL.[1]

Large nursery-grown, oft-transplanted trees, may be removed with as much certainty of their living as small ones. The hardy evergreens, such as the Norway spruce, Scotch, Weymouth (or white), and black Austrian pines, may be removed from the height of twelve to eighteen feet as safely as from two to four feet. The method of removing is the same as of small trees, and they have no more need of a large ball of earth to secure their growth than a plant of twelve inches. True, they must be taken up with great care to preserve the roots from breaking on being moved, or from exposure to a dry atmosphere, and when set, especial care must be taken to keep the roots in their natural position, thoroughly packing the earth among all the roots with the fingers, so as to exclude the air and retain moisture. This should be done by suspending the tree in the hole, which should be made sufficiently large not only to receive the roots of the tree, but also the planter to readily get to his task. The earth must be in fine tilth for planting corn, and must never be wet or muddy, and when thus planted the earth around should be pressed thoroughly with the feet, and when well planted, a quantity of coarse mulching of rotten straw, leaves, or, better, spent tan-bark, should be put around the tree and cover the surface from two to four feet on all sides, and from three to six inches in depth; but do not pack too closely against the trunk of the tree. Three strong stakes six feet high should be set four or five feet from the tree at equal distances from each other. A collar or band should be fixed around the tree five

[1] *Report of Iowa State Horticultural Society*, 1857, p. 22.

or six feet from the ground, to which strong hay bands should be fastened, and then to each stake a piece of fence-wire, which will not shrink or expand.

In the transit, the roots should be secured with moist fine straw, hay, or moss, so that they shall not at all lose their native condition. When the tree is thus set a few pailsfull of water may be poured upon the ground so as to settle it, as if a great rain had done the work. When dry, spade up often, and mellow the soil to give the air circulating and condensing room in hot weather. Then replace the mulching about the tree. The less of earth retained in which the tree formerly stood the better, as from it the substance or nutriment necessary to feed the tree is entirely exhausted, and the myriads of feeding roots running off in every direction have been left in the ground. To retain the entire ball as when removed in the frost, would be to not only stop the growth of the tree, but to starve it to death before the fibrous roots could extend far enough to procure necessary food. I have had large evergreen trees stand thus, scarcely living for three or four years, and only from freely feeding the ball with liquid manure were they kept alive; for in our ignorance we supposed we must remove as much earth as possible to make an evergreen live. We now send our large trees off by the car-load that are several days on the transit, and yet all are reported to live.

The difference between the forest-grown evergreen and the nursery-grown is, the former has but few roots, the latter has them in great abundance, and numerous in proportion to the number of times it has been transplanted, by which a great mass of central roots hold in their custody with what may be called "a death grasp," a quantity of earth, while the former will retain none. The tree also makes a more compact shade and more beautiful for oft transplanting. Perhaps no tree in the whole forest family is more tenacious of life when rightly handled, and in the right season, than the evergreen, and no tree is more sure to die from improper exposure. The sap of the evergreen is resinous, and coagulates in the sun's heat as soon as the bark of the root becomes warm in a dry atmosphere, and cannot be dissolved by any application whatever; the flow of life is obstructed and consequently the tree dies. But let the roots be kept moist, the great supply of resin in every department of the tree more active and abundant from its ever-living foliage, every leaf of which forming a part of the active life-giving influence, becomes more tenacious of life than any other tree. Pine trees were taken from my ground last spring, each one of which filled a lumber-wagon box, and only one could be carried in the load, and yet grew apparently as well as if left standing in their native bed, though not as much. There have been many hundreds of large trees taken annually from my grounds, and yet only in the case of bad treatment have any perished.

To the above the secretary adds a remark, that it is highly important before setting trees that have had their roots puddled, to dip them in water to dissolve or soften the soil that has dried upon them. If received late in the fall, he advises that they be heeled in, in a sloping position, just before the ground freezes, the soil being finely mingled with the roots and between the tops, and thus cover them completely. If planted in the fall, they will usually dry out, especially in a snowless winter, and all living circulation, except in the roots alone, will be thereby forever stopped. He adds as his experience, that the white pine is one of the easiest and safest of all evergreens to plant.

MISTAKES IN PLANTING FOR ORNAMENT.[1]

In planting for ornament, a want of taste is often exhibited in arranging the specimens. A little careful thinking before commencing operations will often avoid after-regrets over our mistakes. It is a mistake to plant trees too close to our dwellings. It is a mistake to plant all trees in parallel lines, as they look stiff and repulsive to the eye. Still, one row running parallel to the public road is admissible; but in this case do not plant them too near together, so as to obstruct a view of the road when they attain size and age. We may also suggest that obstruction of desirable points of view should be considered in all our planting of trees. Plant the inside rows in graceful curved lines, with here and there a group of from eight to ten acres. Plant only one variety of trees in each group; but do not plant all the trees in curves and groups. Single specimens properly distributed are objects of interest to the eye, and where the size of grounds permits eight or ten trees in a circle present a fine appearance. Do not mix deciduous trees with evergreens in groups, rows, or circles. It gives a mixed, broken expression to the lawn in winter. While we may imitate nature in our groupings, yet it is a part of the art of prairie and city lawn-making to modify, and even improve on nature's capricious modes of planting and arranging.

[1] From a report by Samuel Bowers, with discussions that followed. *Iowa Hort. Report*, 1875, p. 97.

Failures have often been encountered in transplanting the larch, by overlooking the important principle that the top should bear a corresponding relation in its leaves to the root in its radicles. Many of the latter are necessarily torn off with the most careful transplanting, and it is a safe rule to shorten the branches in a corresponding degree. The larch should be planted early in the season.

THE ASH AND THE LARCH.

In an article by Mr. Arthur Bryant,[1] on the ash and the larch, he mentions the white ash as one of the most important timbers in the Northern States, and concerning the difficulty of raising from seed he says:

If the seed be sown soon after gathering from the tree, without drying, it will come up well in the spring; but if dried, a great part will often fail to vegetate the first year, even if kept through the winter in damp sand. Care must be taken not to cover too deeply. Probably forest trees, as well as others, often fail from this cause. When self-sown, they have no other covering than leaves, or a little earth when concealed by mice or squirrels. If sown in autumn, ash-seed should be covered with litter during winter, to prevent washing out by rains.

It seems very probable that the seed of the green ash is as often gathered and sown as that of the white. The green ash is common along streams in the West. It produces seed more frequently than the white ash, and upon small trees, and is, therefore, more easily collected. The seed vegetates with more certainty than that of the white ash, even if sown dry; and the young trees grow more rapidly for the first year or two. When in leaf, it may easily be distinguished from the white ash. The timber is similar in quality, but it has the disadvantage of never becoming a large tree. The white ash is somewhat variable in its characteristics, and some of these variations have formerly been named and described by botanists as permanent varieties, or even species. It belongs to northern latitudes, and only obtains its fullest development in colder climates than that of Northern Illinois. The blue ash abounds in more southern latitudes than the white; it is in every respect as valuable, and has the advantage of being more durable. The combination of strength, lightness, and elasticity in ash timber renders it superior to any other native wood for many purposes, and the demand for it must always be extensive.

Much has been said and written in praise of the European larch; but, nevertheless, little if any notice has been taken of its peculiar fitness for railroad ties. [The writer highly commends this timber for this use, citing English authorities. It grows rapidly, closely, and in fifteen years becomes 50 feet high and 8 to 12 inches in diameter. It should never be planted on wet land.] The American larch has been eulogized as fully equal to the European in durability. Michaux describes it as having the same properties. In the British Provinces north of the Saint Lawrence, and in Newfoundland, where it is highly esteemed, it grows upon upland, forming large masses of forest. In the United States it is found only in swamps—never on upland; a fact which Michaux regards as evidence that the climate of the northern limits of the United States is too mild for its constitution. From all the testimony the writer has been able to collect from those who have used it, it appears that when grown in swamps, in the United States, it is by no means remarkably durable; whether this is owing to soil or climate, is a matter of uncertainty. The European larch is found principally in the central and southern parts of Europe, and is therefore better suited to the climate of Northern Illinois than the American species, which reaches perfection only in a much colder climate, and is, likewise, of slower growth.

LARCH PLANTATIONS OF THE DUKE OF ATHOL.

The plantations of larch by the Duke of Athol have been often mentioned, and were begun in 1728. Between 1740 and 1750, James, then bearing this title, planted over 1,200 larch trees as an experiment; the tree being then new in Scotland. In 1759, he planted 700 more, mixed with other kinds, on a hill-side very poor and stony, and with good result. His successor, John, first conceived the idea of planting the larch to the exclusion of other kinds, and covered four hundred acres of sterile

[1] *Transac. of Michigan Pomological Society*, 1873, p. 439.

hill sides with this timber. He died in 1774, and his son, Duke John, continuing the practice, had, in 1783, planted 279,000 trees. Between 1786 and 1791, he planted six hundred and eighty acres with 500,000 larches. He continued the practice till 1826; when he and his predecessors had planted more than 14,000,000, covering more than ten thousand acres. It was estimated that the larch in seventy-two years gained its fullest value; and before reaching this age the trees should be thinned to 400 on an acre. Estimating the trees at fifty cubic feet, worth a shilling a foot, the product would be £1,000 per acre on the poorest land for agricultural purposes that could be found in the country.

The condition of the forests on this estate was described in 1873[1] as follows:

> The woodlands extend to over ten thousand acres, divided into five districts, each under a separate forester. The woods were still mainly larch, but it had in many cases been planted in soil better suited for the Scotch fir. But one man-of-war frigate, the Athol, had ever been built from the larch, it having fallen into disrepute for ship-building on account of the disease which had appeared within the last thirty or forty years, and the recent substitution of iron for wood, which had reduced the calculation of £1,000 per acre to £150 or £200. The disease appeared universal, and no remedy had been found short of cutting off and replanting. It appeared to be atmospheric, and appeared as a fungus-like growth on the stem of the tree, generally near the axils of the branches, then developing itself as a blister, and finally a hole or wound, as if a branch had been rudely broken off. There was still a fine larch wood of three thousand acres, covering hills that rise sixteen hundred feet above the sea. The forester in charge approved the practice of removing the lower dead limbs of the larch, which could best be done in very dry, clear weather, whether warm or frosty, as the branches were then brittle. Plantations of Scotch fir and other conifers were being introduced, and the sycamore-maple was found to flourish extremely well. Larch trees planted by the Duke of Athol in 1743 were in 1795 nine feet three inches around at four feet from the ground, and one hundred feet high. In 1869 these trees measured more than sixteen feet around, and were one hundred and twenty feet high.

RATE OF GROWTH AND DURABILITY OF THE EUROPEAN LARCH.

The experience of European observers is very generally united in assigning great durability to this timber, and these opinions have been often quoted in essays intended to encourage its growth in this country. Carrière, after describing eight species of the *Larix*, remarks that this tree was known to the ancients, and that it is cited by Pliny as most valuable on account of the fineness and elasticity of its wood. He highly commends it as well for ornamental planting as for its rapidity of growth, the large size that it attains, and the superior quality of its timber.[2] Laslet says:[3] "The wood is of a yellowish-white color, tough, strong, and occasionally a little coarse, but it is generally straight and even in the grain. It works up tolerably well and is considered to be very durable, but has the serious drawback of excessive shrinkage, with a tendency to warp in seasoning." Grigor says,[4] that when favorably situated no tree becomes so valuable in so short a time, and that it is particularly durable as posts and palings, and in all structures that come in contact with the ground. It is constantly employed for railway sleepers, for mill axles, and in ship building. These opinions might, in fact, be extended almost indefinitely, and with but little to be said against it. It also possesses qualities which we scarcely have seen noticed in connection with its culture in this country, as the source of tanning material in its bark and of Venice turpentine in its resinous sap.

---

[1] *Reports on Forest Management*, by Capt. Campbell Walker, p. 115.
[2] *Traité général des Conifères*, p. 280.
[3] *Timber and Timber Trees*, p. 250.
[4] *Arboriculture*, p. 232.

A section was exhibited by D. C. Scofield, of Elgin, Ill., in 1874, which had been imported as a small plant in 1858, and had grown to nearly a foot in diameter in thirteen years. He also exhibited a branch a fourth of an inch in diameter which had been seven years among decaying rubbish on the ground and was still hard and sound. This test was claimed to demonstrate the remarkable durability of the European larch in the climate of Illinois, while the native species (*Larix Americana*) would not probably have lasted even half of this time.

Its rapidity of growth, beauty of foliage, and general value as a screen and ornamental tree have been sufficiently proved in this timber as grown with us. But has its durability as a post, or when in contact with the ground, been proved? We apprehend that this durability depends upon the conversion of sap-wood into heart-wood; a change that has not very often been observed in the larch grown in this country or at least in the West. The Conifers, as a class, are found stronger and of better quality in proportion as their growth has been slow.

In reference to the law which governs in the formation of wood, it is remarked by Bagneris[1] that in the broad-leaved species, the vessels of the annual layers of growth are either distributed equally, as in the beech, hornbeam, poplars, willows, &c., or are congregated nearly together at the interior of the ring, and are wanting or very small and scattered toward the exterior. This inner or porous layer is of spring growth, and about the same in width from year to year. The outer portion of the year's growth, formed later in the season, and generally called the autumnal layer, is composed of heavy, compact, woody tissue, and this varies in thickness from year to year, being sometimes thick and at others thin. These woods are therefore heavier, denser, and for most uses better in proportion to the rapidity of their growth. To this class belongs the oak, ash, and other kinds which show their rings conspicuously in section. Their heart-wood is generally different in color from the sap-wood, being stronger and more durable; while in the kinds that have their vessels scattered through the whole growth of the year there is not much difference in color, density, or durability between the heart-wood and the sap-wood.

But the conifers have no ducts as in most other exogenous woods—their ligneous structure being made up of a peculiar kind of tissue, differing from common wood fiber, which may be known under the microscope by the numerous thin circular spots in the walls of the wood cells. These are found in no other woods except the gymnosperms. The outer margin of the annual layer, is in this class made up of harder and denser tissues than the inner, and this harder part is generally of about uniform width from year to year. The difference in growth is expended upon the inner and softer portion, and varies in thickness according as the amount of growth has been greater or less. This harder portion on the outer margin of each year's growth gives the wood more strength and durability, at least until the more porous part has been filled by resinous deposits, as in heart-wood. For this reason, conifers of slow growth, in which these hard tissues are more abundant, have their wood stronger and better for most uses than the fast-growing kinds.

In visiting the plantation of Mr. C. D. Scofield, at Elgin, Ill., during the last summer, he remarked that his larch, set as posts, scarcely lasted three years. It by no means follows that durability would not be gained with age, and the formation of heart-wood, or that this quality might not be imparted by injecting the timber with mineral salts.

[1] *Manual of Sylviculture.* Translation by Fernandez and Smythies, p. 31 and 59.

It is further probable, that the quality of wood may be found to vary with the soil, and that the larch, grown on high gravelly land, would differ from that of the rich prairie-mold. It is within the knowledge of all lumbermen that *sap pine* has no durability in the ground. It is reasonable that *sap-larch* should exhibit the same properties. We know that the pine in our soil and climate acquires with age the most desirable qualities, and it is equally probable that the same may be true of the European larch. It is probable that the durability of this timber would be increased by stripping off the bark and allowing it to season for a time before cutting.

CALCULATIONS OF COST FOR ONE ACRE OF LARCH; BY M. L. DUNLAP, OF CHAMPAIGN, ILL.

Trench plowing	$5	Cultivating	4
Harrowing and rolling	2	Hoeing the young trees	5
Three thousand plants	30	Cultivation five years	15
Freight	1		
Spade and setting	3	Total	65

The cost of land, interest for six years, taxes, and the above in five years, amount to $125, making the total cost at that time $190. No further attention would be needed for the next six years, when, with interest and taxes, the cost would have amounted to $320.

The crop at this time should consist of 2,500 trees, allowing 500 for loss. Of these, 100 may be taken out, leaving 1,500 standing. Those taken out would give 1,500 posts, worth $350, less $30 for cutting, and leaving $320. Thus, in twelve years, the partial crop will have paid for the land with interest, and we have 1,500 larch trees, large enough in twelve years more for railroad-ties, and worth, at 50 cents apiece, giving $800 for the land and trees, at the end of twenty-five years.[1]

SUGGESTIONS ON PLANTING—IOWA EXPERIENCE.

Mr. Suel Foster, of Muscatine, Iowa, in a prize essay on forest-tree planting, offers the following suggestions as applicable in his State:[2]

> The larch is of tolerably rapid growth; growing half an inch or more in diameter each year for the first ten years, and the next ten years fully equal to one inch. This is in size equal to our black walnut, and it grows much better and straighter. The little trees should be bought of nurserymen, for it is a nice and particular thing to raise the larch or evergreens from seed. I would recommend to the farmers of Iowa to buy European larch at two years old, at $10 to $15 per thousand. They should be set in nursery rows, 4½ feet apart, and 1 foot in the row, so that when one row is taken out it will make a wagon-road through the grove. Larch must be moved very early in the spring, for they are among the very earliest trees to start to grow. The ground should be plowed very deep in the fall, then plowed in the spring, as soon as possible; harrowed and pulverized very finely by turning the harrow bottom up the last time. Then stretch a line and set with a spade. Have a mud-hole to dabble the roots all in. While the man uses the spade, a boy can handle plants. About 2,000 will be a day's work, and will cover about a quarter of an acre. They must be carefully plowed and hoed for two years, and if the weeds start too quick in May and June, the third or fourth years they should be plowed.

Cost.—8,000 plants for an acre, $80; setting out $8; plowing and hoeing the first year, $8; plowing and harrowing the land before setting, $4; second year, $4; two years after, $4; interest on the land at $50; eight years, at 8 per cent.=$32. Total cost of an acre of European larch, at eight years, $140.

---

[1] Cited in an address by Dr. John A. Warden, in January, 1873, before the Kansas State Board of Agriculture. Report of that year, p. 262. See also *Ohio Agricultural Report*, 1871, p. 55.

[2] *Iowa Agricultural Report*, 1870, p. 328.

Credit.—By taking out 3,000 plants after two years' growth, to set in other ground, at $20 per thousand, $60. It is calculated that 1,000 in 8,000 will die, although those who are accustomed to handling and cultivating will not lose so many. Then half the plants are taken out, leaving them 2 by 4½ feet. When they are eight years old they will be poles fit for fence, two or three inches through and fifteen or twenty feet high, and another thinning out must be done, by taking out 2,000, leaving the grove 4 by 4½ feet. These poles are worth 5 cents each, $100. At eight years one acre has cost $140, and has a credit of $160. Those transplanted at two years from setting should be set 4 by 4½, covering about an acre and a half, and will cost, in setting out and cultivating two years, something over $100, including the plants at $60.

MODE OF PLANTING OAKS RECOMMENDED BY THE SOCIETY FOR THE PROMOTION OF AGRICULTURE, ARTS, AND MANUFACTURES.

To this society, formed in New York as a State institution in 1791, may undoubtedly be ascribed the first direct recommendation of a society for the planting of forests for their timber in the United States.

In a circular issued at the beginning, they made particular inquiries concerning the propagation of the locust-tree, the possibility of introducing the white mulberry, and the profit and propriety of raising in nurseries and transplanting hickory, chestnut, beech, ash, and other trees for fencing and fuel, and the planting of hedges.

About 1795, a committee appointed to consider the best mode of preserving and increasing the growth of wood and valuable timber, reported in favor of recommending this where the soil was not better adapted to other uses. One of the committee, twenty years before, had allowed land worth $2.50 per acre to grow up to timber, then worth $12 per acre, besides the land, which had been improved in the mean time. They insisted upon the importance of fencing out cattle; suggested the propriety of cutting off old woodlands entirely, so as to give the young trees an equal start; showed that woods should not be thinned too much, as this would favor the growth of grass, to the injury of the trees; and pointed out a method of planting oaks that deserves notice:

> Oaks are best propagated by leaving the acorns on the surface of the ground, covered with the grass; but in this way the acorns are exposed to be devoured by animals. To prevent this it is recommended to preserve them through the winter and plant them in the following manner: First make a bed of loam about six inches deep; on this plant the acorns about two inches deep; over them lay another bed of six inches of earth, over that another layer of acorns, and so on, as far as the occasion requires. The whole must be covered with earth, to preserve them from the frost. Early in the spring the bed is to be opened, when the acorns, which will have begun to shoot, are to be planted about a foot's distance from each other.
>
> Another method of planting them, is to dig a small hole with a pick-ax, and drop the acorn, covering it with earth. This is a very simple method, but care must be taken not to bury the seed too deep; two inches is found to be the best depth; the less covering the better, provided the acorn is secured from birds and other animals. Another practice is to pare the earth with a plow and plant the acorns in rows, covering them with the turf. This is not a great deal of labor, and will secure the acorns from animals. The distance of the rows may be at any man's pleasure, but the thicker the trees the sooner will the ground be shaded and the turf destroyed. As the young trees advance the weaker ones will die, and the vigorous and thrifty ones only survive. * * *
>
> It is probable that great numbers of old fields might, in this way (the cultivation of trees), be converted into very profitable lands. It is a circumstance that deserves particular notice that vegetation is ordained to be the natural fertilizer of the earth, and it is a happy arrangement in the economy of nature, that the most useful vegetable productions furnish this fertility in the greatest abundance. Grass contributes to enrich land much more than weeds; and useful forest-trees, by the leaves they de-

posit every autumn, create a deep, rich mold that benefits the earth much more than useless shrubbery.

Thus, trees planted on impoverished fields, will, as they grow, furnish the earth annually with a portion of vegetable nutriment, and the land, while it sustains a valuable forest of wood, is continually growing richer, and fitted for cultivation when the wood shall be taken off.—*Transactions of Soc. for Promotion of Ag., Arts, and Manufac.* 2d *ed.*, I, 321.

PLANTING OF OAK.

As the oak is deemed the most valuable timber that is planted, the methods of cultivation have been carefully studied, and different systems prevail among foresters. It will be admitted that an oak started from an acorn and left to grow on the spot, receives no check in its growth as do transplanted trees, takes deep hold from having a good tap-root, and seldom needs pruning. But the extreme liability to destruction of the acorn by squirrels and mice is the greatest obstacle to success, and leaves the alternative of transplanting from nurseries as the surest and, frequently, the best method.

We often see in a transplanted fruit tree the top die down and sprouts appear from the root, one of which, if spared, may become a vigorous tree. This is very liable to happen with the oak in bleak and exposed situations, and foresters sometimes anticipate this by cutting them over by the surface of the ground after they have been planted a year, so as to develop new shoots, one of which is saved.

In sheltered situations this becomes needless, and no time is lost in bringing forward the shoot as soon as possible.

The managers of government forests in England, where oak is being raised for the royal navy, rear the trees from the acorn, and the trees are found to grow for the first few years more rapidly than if transplanted.

Much difference of opinion has prevailed as to the distance at which young oaks should be planted; in fact, as many views have been expressed as there are differences of circumstance, and each in its place may be best. It is often of advantage to grow other timber with the oak, and for this the fir has been planted in Scotland with best results, and this in exposed situations becomes essential as a shelter till the oaks attain a size to take care of themselves. In such a case, a distance 10 to 12 feet apart for the oaks, and the same for the firs, making the distance between trees of alternate kinds 3½ feet to 4 feet. The firs are cut out in a few years. It is thought that, besides the shelter thus gained, the oaks grow more rapidly with this mixture of young evergreens among them. (*Brown's Forester, p.* 364.)

With the oak, its value depends rather on the *quality* than the *length* of its wood, and for ship-building (its principal use) a straight trunk is sometimes less prized than one of a proper curve. Now this wood cannot be grown of best quality unless free access of air is allowed, and hence dense plantings are not economical.

James Brown, a Scotch writer, mentions two lots of oak timber, one one hundred years old, with 200 trees to the acre, that sold for £360, and another of ninety years old, with 109 trees, that brought £868. The latter had grown with free access of air, and had an abundance of bends fit for ship-building. But such trees growing low, and with spreading branches, do not yield so much bark for tanning, and for this use a dense, tall coppice is best for *quantity*, although its *quality* is not equal to that of wood grown in open places.

Oak grown in free air weighs almost double that from a dense shade, and its bark contains more tannin.

PLANTING UPON MOOR-PAN SOIL.

Moor-pan is a term applied to certain soils, chiefly in sandy and low-lying countries, overgrown with the heather (*Calluna vulgaris*), and sometimes with *Erica* and other plants belonging to the natural order *Ericaceæ*. It does not occur in a loamy soil, even where these plants grow, and its formation appears to belong to the present geological period, and to the action of the humus of these plants upon the chemical constituents of the soil. It is of a yellowish black, or yellowish color, is generally from one to two feet below the surface, and varies in thickness of the layer, from half an inch to twelve inches, being generally from three to six inches. It is generally too hard to be broken up by the plow, and can only be broken by a pick or iron bar. It consists of from 80 or 90 per cent. of silica, cemented by heather-humus, and shows a slight percentage of iron sesquioxide and of alumina silicate, with traces of phosphoric acid. It is impervious to water, and the surface underlaid by this stratum may be excessively wet, when proper drainage is wanting. The roots of trees are scarcely able to penetrate it, and the proper method of planting in timber is to thoroughly break up this crust, so as to allow the roots to penetrate the subsoil. Extensive tracts of land, underlaid by moor-pan, occur in Europe; but as the heather-plant is scarcely found in our country, these conditions are for the most part absent; but whenever analogous conditions exist, they are to be treated in like manner.[1]

ON PLANTING IN EXPOSED AND MARITIME SITUATIONS.[2]

Those engaged in planting in extremely exposed or maritime situations, need not look for immediate or certain success, nor be disheartened by some failures, for success requires much preparation and perseverance to insure even moderately good results. Some trees will grow with various success in the most exposed situations when the soil is suitable; but unless it is so, success becomes doubtful, and the trees will often be slow in getting fully started. When the soil and subsoil are stiff and tenacious, it must be first thoroughly prepared and loosened by trenching or plowing. The former, although more expensive, is by all means the most profitable in the end, and should be done to a depth of 20 to 24 inches, especially where the grounds are small or designed for ornamental planting. The surface soil should be kept as much as possible on the top of the trenched ground, so that the young roots may get a good start. The under soil being loosened, is improved by the action of the atmosphere, and by the washing of good soil from above, and is kept from becoming very wet by the drainage, which must always be sufficient to remove the excess of moisture from rains or stagnant water. Open drains are the best, and their width and distance apart must be regulated by circumstances. Without this trenching young trees in a stiff soil are apt to get loosened by the winds, which, by swaying back and forth, form a hole around the collar of the plant, which admits air to the roots, or water, which freezes to the roots, while the trees are often laid broadside by the winds, and they make little or no progress for a year or two. They may also die for want of nourish-

[1] See Walker's *Report on Forest Management*, p. 148, for ample information upon this subject.

[2] Condensed from a prize essay for which a premium of five sovereigns was awarded to its author, Lewis Bayne, Kinmell Park, Abergele, North Wales. From the *Transactions of the Highland and Agricultural Society of Scotland for* 1876, *p.* 66.

ment, unless the roots can penetrate the soil, which they can more easily do when the soil is thus prepared, their roots sending out their spongioles and securing good growth, which enables them to withstand the storm and make upward growth.

But if the soil and subsoil are light or sandy, and dry, no preparation of this kind is needed, as there must be firmness enough in the ground to allow the plants to get firmly planted. A plantation when inclosed and planted will still require great attention and judicious management until the trees have grown to timber size. If neglected from want of timely trimming, and allowed to run up slender, their chance of success by late trimming will be small indeed, for, having but small roots, they will be less able to withstand a storm.

In a plantation of about three acres, four miles from the sea and 600 feet above it, the soil being a cold clay loam, was not well adapted to the early growth of young plants. The trees were a mixture of common and Turkey oak, ash, sycamore, beech, elm, and a few birch, with one or two laburnums and service-berry trees along the margin, and about forty-five years old. The subsoil rested upon limestone which had been removed in places 12 to 15 feet in depth. The trees were much larger in these depressions because they were more sheltered, soil was drier, or more mixed with rubbish and small stones, allowing room for the roots, and from not being as crowded as on the level parts. The trees on the level part were very small of their age from exposure, coldness of the soil, and neglect of trimming when young. The beech and sycamore trees had prospered much the most. Along the margin was a row of ash with a few wych elm, and one or two Turkey oak, laburnum, and service-trees, and all very much exposed. The Turkey oak contained much more timber than its neighbors, being larger than the ash or elm trees, but the branches and young shoots of the elm had fared best. The ash trees were badly injured, their branches growing on the sheltered side chiefly. The laburnum and service trees had stood the exposure well. One or two larch trees had been nearly ruined.

Around this small plantation another had been planted ten years before, and inclosed, the exposed side having an upright paling-fence 4½ feet high, the openings being 1½ inches apart, which did good service while it remained; but upon removing the fence it was soon found that the trees had been too kindly nursed by the shelter to withstand the severity of the exposure, many Scotch firs being blown down, and others half over, with their roots partly out of the soil. The birch trees fared no better, and many appeared as if they had been pulled over.

This shows the need of bringing up young trees in bleak places, as hardy as possible, so that they may take girth, in proportion to their height, and make good root growth so as to hold them firm against severe winds. If a shelter is provided for young trees in such places it should be a good stone wall or dike with a rough and irregularly projecting coping, by which the wind is broken as it rises on the wall, and prevented from striking the trees with great force, or at once, as it might do with a level coping of the width of the wall. Many prefer artificial paling, brush, or *stake* and *rise* shelter to stone walls or dikes, which do very well if kept up till the trees can do without them, but they are expensive, and do not furnish a permanent inclosure like a wall or dike.

In a plantation of about ten acres, set with oak, wych elm, Scotch fir, larch, and spruce, the location was about two miles from the sea, and 40 feet above its level. The soil was sloping, and of different qualities, some being pure sand, other parts light and thin and poor loam, and

sandy subsoil, and parts poor loamy clay with clay subsoil, limestone lying deep under all. It was partly inclosed and had formerly been under or furrow drained with pipe tiles 3½ feet deep and 30 feet apart, and before planting it had been deeply plowed, and again drained with open drains 15 inches deep, and 30 feet apart. The plantation was twenty years old, and had been repeatedly thinned, the larch and spruce being taken out most on the exposed side, giving preference to the hard woods and Scotch fir as standards, while on the sheltered sides spruce firs had preference, and the hardwoods, larch, and Scotch fir removed. The plantation appeared healthy throughout, except on the extreme margin, where a few larch and spruce had been left in thinning. The larch appeared less hardy than the spruce, even in better locations, and they had all lost their leaders, and were bent and twisted, and many were dead or dying, but in sheltered places they appeared better. This seems to show that the larch is not suited for planting in exposed or maritime situations. The spruce on the exposed side kept growing, but made little progress. But few had died, but many were one-sided, and their foliage on the exposed side was quite red. Where sheltered, the spruces had made rapid progress, and outgrown both the larch and Scotch fir. The last had grown well, and in late years had made rapid progress. Although one-sided where most exposed, and with fewer branches, they gave proof of endurance over the larch. The oaks grew moderately well where the soil was good, but were more stunted in appearance than their better-shaded neighbors. The wych elms appeared very hardy, and withstood the winds better than the rest. They had never been pruned, and had branches near to the ground, thus affording good shelter to the rest. The larger the quantity of small branches the better, as they yield to the wind without breaking. Near this plantation were rows of Austrian pines and English yews, which had been planted about twelve years, and appeared healthy, but had not made much growth. The pines extended their branches toward the wind, as well as from it, and they showed no sign of the wind cutting their foliage. A few damson-plum trees grew well, and blossomed, but seldom produced fruit.

Another plantation, embracing about four acres, a mile inland, was near sea-level and exposed on all sides. Soil heavy clay, and subsoil so tenacious that planting had only been attempted for shelter. The trees were oak, ash, elm, sycamore, beech, poplar, willow, alder, and Scotch firs. Some larch had been planted but they were all dead, perhaps from unsuitable soil, as some in the interior were sheltered. The trees were small for their age. On the north side, facing the sea, was a margin of Huntingdon willows, and a few alders and poplars, none of which had prospered, but the poplars had made more wood than the other trees. On the west side, also much exposed, were wych elms, with a few ash, sycamore, and beech trees, and one or two oaks. The oak and beech trees were rather small, as also the elm, but the latter appeared very healthy, and their foliage and young wood appeared to stand exposure better than the others. The sycamores, although small, were healthy. The south side was sheltered and planted with poplar, ash, and elm, the former being much larger than on the exposed side, partly because they had drier soil. The oaks were few, and none so good as the elm and ash, where the latter have room. The sycamores were small but healthy, and the beeches about like the sycamores, and retained their leaves longer green, the tips decaying a little on the exposed side. The general appearance of the foliage on the outward exposed sides showed the effect of cutting winds by the brownness of the leaves. It was pro-

posed to cut down this grove and draw up a young plantation from the stools, as some of the trees were too slender from want of thinning.

The following remarks may be made concerning the endurance of trees in exposed situations:

The *Common Oak* does not do well, being often one-sided, and leaning away from the blast, with a stunted appearance, and often covered with galls, the leaves having a dry and curled, unhealthy appearance.

The *Turkey Oak* grows faster and suffers less.

The *Scarlet Oak* does not thrive in even moderately exposed places.

The *Ash*, in hedge-rows and in well-prepared soil, attains a moderate size, but on the margins makes less progress, and on the whole is not desirable in exposed places, unless mixed with other trees, when it makes considerable growth.

The *Wych* and *English Elms* appear to be suitable, especially the former, which, although they do not grow to a large size, make a good shelter, and are not liable to be blown down or one sided. The writer considers it a better margin-plant for exposed places than any of the trees above named. The English elm is less hardy, but in good soil grows to a large size, even in exposed places, with a good shape and healthy foliage.

The *Sycamore* grows well, in some instances attaining good size and age in bleak places, while in others it does not. From the round shape and closeness of its branches and foliage, it is a first-class shelter-tree when of full size.

The *Beech*, in dry, light soil, grows well in the wind, and, from retaining its leaves till late, it is good for shelter; but in a heavy and stiff soil it grows slowly and dies early.

The *Horse Chestnut* is not well adapted for exposed places, as both buds and branches are liable to injury from even moderate winds.

The *Lime* is a tender tree in bleak exposures.

The *Black Italian Poplar* does not grow well nor make much wood, the branches and spray dying out in the winds.

The *Common Black Poplar* grows better, and in exposed hedge-rows will sometimes attain considerable size; but when large, is much liable to be broken by the winds.

The *Lombardy Poplar* appears to be very hardy, but, from its upright growth, does not afford great shelter, except when planted close, when it answers the purpose in its young state.

The *Huntingdon Willow* generally grows one-sided, but near the sea produces good shelter.

The *Birch* grows well in moderately windy places, and, from its adapting itself to poor soils, will thrive in high and exposed places, where few other deciduous trees will grow to any size.

The *Common Alder* is not suitable for planting in the face of severe winds.

The *Wild Cherry*, or *Gean*, stands the storms very well when young, and has a healthy and ornamental appearance; but when old, is liable to lose its branches by the wind.

The *Mountain Ash* grows well, and, having a good shape, may be recommended as an ornamental and shelter plant in exposed sites.

The *Service Tree* is a little one-sided but not disfigured by the wind, and may be called hardy.

The *Laburnum* stands the wind moderately well, but is liable to have its limbs broken off at the axils.

The *Common Thorn* does well in hedge-rows, and, although one-sided, affords a good shelter.

The *Sloe, or Black Thorn*, grows abundantly in hedges, and thrives in bleak places near the sea.

The *Evergreen Oak* has the appearance of being hardy, retaining a good shape and healthy foliage.

The *Holly* makes a good hedge-plant in exposed places, as it grows close, and although much blown to one side, it attains considerable size and affords good shelter.

The *Hazel* grows to a moderate size in extreme exposures, but is much one-sided and less hardy than the thorn.

The *Elder* grows fast, and is a good nurse-plant in suitable places.

The *Portugal Laurel* does not make great progress in the face of the wind, and is one-sided, and very much cut on the exposed side.

The *Common Laurel* has rather a thin foliage, but takes a good upward growth.

The *Arbutus* grows in moderately-exposed places in a very healthy state, with beautiful foliage, and well covered with flowers and fruit.

The *Scotch Fir* are often very one-sided when from twelve to twenty years planted, and very bare of branches on the windy side. Old trees generally have a healthy appearance, and are not much cut by the wind.

The *Austrian Pine* is very healthy and robust, with its branches growing out well

against the wind, and the branches and foliage retaining their natural position and color. It does not grow upward like the Scotch fir, but more stiff, and with an abundance of branches. It is, therefore, much recommended for margins of exposed plantations.

The *Pinaster* does not appear to be hardy, and is liable to be blown one-sided.

The *Larch* is not at all hardy in very exposed places, and shows signs of early decay.

The *Common* or *Norway Spruce* is generally one-sided, and the foliage browned on the exposed side. It is not adapted for extreme exposures.

The *Silver Fir*, growing in very exposed situations, with hard-wood trees, has been found to thrive extremely well.

The *English Yew* will grow to a good size, but is one-sided when exposed to prevailing winds, with an appearance of average hardiness.

The *Cedar of Lebanon*, although growing to a considerable size, is generally a little one-sided, and its top growing away from the blast.

The *Cedrus Deodora* does not succeed well in exposed places.

The *Weymouth Pines* do not succeed in exposed places, and in moderately-windy places lean much from the winds.

The *Cupressus macrocarpa* grows well out against the wind, and is well worth planting in moderate exposures.

The *Cupressus Lawsoniana* grows moderately well in exposed situations, and keeps its shape fairly well.

The *Thujopsis borealis* makes more luxuriant growth than the latter, and from the strength of its foliage appears better suited than the latter to exposed planting.

As a general rule, the sycamore, maple, and wych-elm have been found to be the most hardy and most suitable deciduous trees for planting in exposed situations, and the Austrian pine among conifers. The evergreen oak, arbutus, and holly, the best evergreen shrubs of large size, and the sea-buckthorn, wild cherry, elder, and mountain-ash, of small-sized trees and shrubs of the deciduous kinds.

In making plantations in exposed situations, it will be found advantageous to have them of as large an area as possible, for trees will in many cases thrive in large masses which would actually starve in small clumps or belts. The soil should be well trenched or drained, and great care should be taken in selecting the hardy varieties that are suited to the soil in which they are planted. The plants should be small when transplanted, and those that are known to stand severe winds should form the margin, while the more valuable kinds are planted in the interior. In many cases it will be found judicious to plant thickly with the view of shelter, and thin early, so as to bring up the trees in a healthy and hardy state, taking girth with their height.

ON THE SOILS AND SUBSOILS SUITED FOR PLANTING.

[The following is an abstract of a prize essay by John Nisbet, assistant conservator of forests in British Burmah, as printed in the transactions of the Highland and Agricultural Society of 1876. The writer, having learned his profession in Germany, admits that his views conform to the practice of that country, which differs somewhat from that adopted elsewhere; but, as the principles stated admit of qualified application in our country, it is believed that the leading points embraced will be of interest to the American reader.]

The growth of any particular tree depends on the nature of the soil and the situation on which it occurs. As regards the soil, we must take into account:

1. Chemical composition.
2. Amount of moisture.
3. Degree of looseness.
4. Depth of soil.
5. Quantity of humus.
6. Nature of the subsoil.

1. *The chemical composition of the soil* affects the tree indirectly, by means of its physical properties (as amount of moisture and degree of looseness or porosity), and also directly, by the mineral matter taken up by the rootlets and deposited in the wood and leaves in their annual

growth. This mineral matter, which remains as ashes when wood is completely burned, forms a small percentage of the contents of the tree, and according to some (Dr. G. Heyer, director of the Forest Academy, Münden), is found in sufficient quantity in almost all varieties of soil. In addition, rain, snow, dew, and hail are continually bringing fresh supplies.

2. *The amount of moisture in soil* is of the utmost importance, for the supply of the rootlets of trees. There is a vast quantity of water given forth through the leaves during the annual period of vegetation. The soil must, therefore, be able to absorb and retain moisture. Loose sand, with a small percentage of clay, absorbs easily, but does not retain it. Binding clay absorbs slowly and to moderate extent, but is very retentive. A mixture of vegetable mold modifies both extremes.

There are five degrees of moisture in soils:

(1) *Wet.*—On lifting a handful, water drops to the ground.

(2) *Moist.*—On squeezing a handful, water drops to the ground.

(3) *Fresh.*—On squeezing a handful, traces of moisture remain on the hand.

(4) *Dry.*—On squeezing a handful, no traces of moisture remain on the hand.

(5) *Arid.*—On being merely rubbed, it flies off as dust.

3. *The degree of looseness.*—The more clay there is in soil the more binding it is, and according as sand or lime is added the more it becomes loose. Binding clay opposes tree-growth, by not allowing the free entrance of moisture and air. On the contrary, very loose soils, especially if shallow, are apt to become dry, and are exposed to the influence of frosts, while trees having no firm support in the shallow, unretentive soil often fall in storms. Here, again, both extremes are modified by an admixture of humus.

4. *Depth of soil* favors the growth of trees, since—

(*a*) More moisture is absorbed, and is retained longer; and

(*b*) The roots are more developed, and the supply of sap is greater, and the cubic contents of the tree are greater than on shallow soil.

The classification of soils according to depth may be—

(1) *Very shallow.*—Less than 6 inches in depth.

(2) *Shallow.*—From 6 inches to a foot.

(3) *Middle-deep.*—From 1 to 2 feet.

(4) *Deep.*—From 2 to 4 feet.

(5) *Very deep.*—Over 4 feet.

Mild, loamy soil, in which sand and lime are present in a higher degree than clay—deep, fresh, and rich in vegetable mold, is favorable to the growth of many forest trees, such as oak. Lime is best suited for beech, ash, maples, elms, black or Austrian pine (*P. austriaca*), dwarf pine (*P. mughus* of Loudon), and yew. As already remarked, a *binding* clay, without sufficient humus, is not suitable for forest trees. In the heat of summer it cracks and injures the rootlets. A soil composed of quartz sand, with a small percentage of clay, fresh and rich in humus, will nourish sufficiently any tree growing in Great Britain, if not too shallow. Soils, if rich (minerally), although they yield trees of greater height and solid contents, will, if moist, produce timber of inferior quality and less durability. Dry and arid soils, if properly treated, will, as a rule, nourish the Scotch fir (*Pinus sylvestris*), along with which the birch might be grown, if advisable. In the North German plain, where pine forests are cut through by railroads, safety belts are planted with birch, to prevent sparks from reaching the tinder-like leaves that cover the soil.

5. *The quantity of humus contained in a soil*, plays an important part in regard to the growth of trees; for by the decomposition of the leaves, carbon and various chemical compounds forming ashes, are returned to the soil. Carbonic acid, formed by the decomposition of humus, affords indispensable nourishment to trees, and decomposes such minerals as occur, so that they become soluble in water and are absorbed by the rootlets in the form of alkalies. Humus also absorbs from the atmosphere ammonia ($N H_3$), oxygen, moisture, &c., all necessary for the nourishment of plants. It has a high degree of power for absorbing and retaining moisture, and is only moderately binding; it renders more loose a binding clayey soil, and binds a loose sandy one.

6. *The nature of the subsoil* affects the quality and quantity of the timber produced, since it materially affects the quantity of moisture contained in any soil. It may be impervious, or cleft in horizontal or inclined layers. Subsoils of plastic clay, or of quartz conglomerate, are the most unfavorable. Loams, marls, or peat, are more suitable (when the latter are not too wet), and such rocks as are moderately cleft, so that the upper soil can be only moderately moist.

Concerning the *situation* of the soil, we must consider—

1. Height above the level of the sea.
2. Aspect or inclination toward one of the points of the compass.
3. Angle of inclination toward the horizontal.

1. *Height above sea-level.*—Trees reach their limit in a vertical direction very soon, as the mean temperature diminishes about 1° F. for each 450 feet of elevation. Trees growing on suitable soils at the sea-level, produce the greatest quantity of timber, and most seed, but the quality is not so good, owing to rapid growth. The following may be accepted as average heights of forest trees in Germany:

1,200 to 1,300 feet,—hornbeam and Scotch fir, the latter in mixed forests growing much higher, but it is comparatively inelastic, and often suffers from snow-break.
1,600 to 1,700 feet,—birch, elm, and in favorable circumstances, oak.
2,200 to 2,400 feet,—beech, maple, ash, and birch (*Betula pubescens*).
3,000 feet (and often higher),—silver fir (*Abies pectinata*), spruce fir (*Picea excelsa*), and larch.

The heights to which these trees ascend mountain slopes, are modified by the following circumstances:

2. *Inclination of the hillside toward one of the points of the compass.*— The greatest quantity of timber is produced on gently sloping eastern, northeastern, and northern hillsides, which are moist and cool. The more southern aspects, however, produce the most durable timber; but young plantations, or natural undergrowth are exposed to the burning rays of the sun and partly to dangerous, late frosts. The northeast, east, and southeast aspects are most exposed to late frosts. The west aspect, when exposed, produces the least quantity of timber, for it is from this point that violent winter storms generally come.

3. *Angle of inclination.*—This has a most powerful influence on the growth of trees, for the greater the angle, the more marked are the differences in the quantity of the timber produced. An inclined plane should, *cæteris paribus*, yield more timber than a horizontal plane.

a. Because it is greater in the ratio of the secant to the radius, and the trees do not stand quite vertical, and

b. Because each tree receives more light on a gradual slope.

In reality, however, this is not the case, for on the hillsides the soil is usually wanting in depth and also in moisture. After heavy rains some-

of the soil is always carried down into the valleys, which are thus enriched from the neighboring hills. According to the angle of inclination, a hill might be described as gently sloping up to 10° from the horizontal; moderately steep, from 11° to 20°; steep, from 21° to 30°, and very steep when over 30°.

In addition to these three chief features, the local climate and the growth of trees are influenced more or less by the character of the surrounding district, and the form, extent, and direction of the ranges of hills on which the forests are.

The various soils suited for different hard-wood trees.

The BEECH (*Fagus sylvatica*), is the only hard wood by nature admirably suited for growth in unmixed forests. Its leaves, rich in potash, decay easily, and form an excellent humus. In high-timber forests, it finds its proper place, growing best where the foliage forms an almost unbroken roof, which hinders the sun from drying the soil. Its period is usually 100 to 120 years, being longer on poor soils. It is not suited for coppice, because its power of sending up shoots from the stool is not great, and their growth is slow; but in lime soils this power is greater. It occurs as coppice under standards where the latter throw much shade on the underwood, or where, as in the case of oak standards, the ground should be well shaded from the sun. On lime, and the milder clay soils, it thrives as standards, but it then overshadows more than any other tree. Its wood is usually worth less than other hard woods in the market. The beech requires a strong mineral soil, fresh and rich in humus. It is often found with the oak on sandy-loamy deposits, if not too dry or too moist; but on poorer and lighter soils, or in exposed places, it grows slowly, and the soil becomes impoverished. The true home of the beech is on lime, basalt, and greenstone if the soil is not too thin. This partiality for lime is shown in the smoothness of bark, the straightness of trunks, and their freedom from branches; the annual growth is great, and reproduction by natural means easy. In fresh, sheltered places on lime, the beech bears seeds early (beginning about the seventeenth or nineteenth year), and continues to do so at intervals of three to five years and in abundance.

The OAK (*Quercus sessilifolia* and *Q. pedunculata*) was relatively more important among forest trees a century or two ago than now. Extensive forests of this timber have since been cleared for cultivation, so that the noblest forests are now among the hills.

On account of diminishing supply and rising demand for oak timber much has been done of late to promote its cultivation. Young trees shelter the soil from the sun, but as they advance they demand more light and room, so that many die unless seasonably thinned. In forests the oak assumes greater dimensions when grown with other oaks alone, for it may be laid down as a rule that *it thrives best with the crown free, the stem sheltered and in shade, and the foot under covering.* The *Q. pedunculata* is disposed to develop many branches but where this is not possible (as in forests of beech and oak) the stem is straight and free from branches to 70 or 80 feet, and the whole height 100 to 130 feet. The tap root penetrates 5 or 6 feet in good soil, so that the subsoil is of great importance in its growth and quality. Moderately cleft and inclined limestones, and the milder clay slates, the richer sandstones and marls, granite, basalt, greenstone and clayey porphyry, and good peat are favorable subsoils for both kinds of oak, as they generally continue fresh, and are not apt to hold water. The timber of this kind is of fine

texture, tough, hard, and heavy. It is the strongest and most durable timber grown in large quantities in Europe, and is indispensable in ship building, in the construction of mills, and structures in or near water, and when submerged is indestructible. The *Q. sessilifolia* does not grow so quickly but has a longer life, is more disposed to form branches, but may under favorable circumstances grow to equal size. The roots do not penetrate so deep, the wood is less tough and elastic, is more easily split, and therefore more prized by coopers. Being of coarser texture it is not so well suited for carving and cabinet work, and being heavier it forms better firewood, the proportion being as 12 to 11. As a building timber it is little inferior to the *Q. pedunculata*. The latter prefers plains, warm, sunny valleys, and outlying hills of mountain ranges, while the former is at home on the mountains themselves. They often grow together, but the *Q. sessilifolia* ascends the slopes to a greater height, although it does not grow so far north and prefers the south and west slopes.

The oak is not by nature intended to form extensive and unmixed forests, but requires the aid of a shade-enduring and soil-improving tree; for the growth of oak depends less on the kind of soil than on its quality, depth, and freshness. No tree is better qualified to perform these functions than the beech. In coppice wood with standards or reserved trees, the oak enjoys the sunlight, and does not throw much shade on the coppice below—acquires moderate thickness, but at the expense of its branches, and comes to greatest maturity at 200 to 240 years, but when well exposed to the sun may be felled much sooner. In order to obtain valuable timber in such cases, the trees must, ere they grow too old, be stripped of their lower branches, as far as practicable.

Oak reproduces itself from stools, and is suitable for coppices, the wood (generally at the period of 16 years) being cut and peeled for tanners' use. The bark is most prized when grown on strong mineral soil on hill-sides in sunny exposures, where the trees have not been too closely planted, and have room for development. It is best before it begins to split. In higher situations the *Q. sessilifolia* is said to yield bark in greater quantity and of better quality than the *Q. pedunculata*.

The growth of oak depends less on the kind of soil than on its quality, the amount of humus, and, above all, of moisture contained in it. The best growth occurs in a deep, somewhat loose loamy sand, or sandy loam, but it thrives well on loam or sand. Although it prefers moisture, it will not grow in marshes unless drained.

The oak thrives exceedingly well when mingled with beech, because its penetrating roots draw their support more from the subsoil, while the beech spreads its roots near the surface. This association does not prosper, however, in exposed situations or on shallow soils.

The ASH (*Fraxinus excelsior*), MAPLE (*Acer platanoides*), SYCAMORE (*Acer pseudoplatanus*), and ELM (*Ulmus*) have much in common, are found on similar soils, and may be classed together as regards their treatment.

The ash must not be reared in pure forests, and must have plenty of light. Its thin foliage does not sufficiently shade the ground, and hence it does well in beech forests. Even among coppices, it yields a good return if not too much shaded by the standards. It grows readily from stools, and may be grown with oak, maple, hazel, linden, sycamore, elm, hornbeam, and beech, with good results. It is most liable to injury from the rapid growth of grass. Dry, poor soils are not suitable, and it desires a moist and even wet soil. Its true home is on rich, loose, strong, mineral soils, abounding in humus, and even on binding ones, if

fertile. It ascends as high as the oak and beech on mountains, and in moist soils it thrives with the alder. The maples can bear more shade than the ash, and in some parts of Holland, on fresh, strong, mineral soils, they prosper as underwood in oak forests, but they cannot bear shade like the beech or hornbeam, and, on the whole, need much sunlight. When they grow in shade, the ground must be exceedingly favorable. For this reason, they are not met with in extensive pure timber forests, but often on rich soils, especially lime, scattered among beeches, singly or in groups.

As standards in composition forests they (especially the sycamore) yield a wood much valued for cabinet-making and carving. Here they thrive on suitable soil, and do not injure the underwood by shading. Even as a part of the coppice they return a good revenue, for they produce numerous shoots, and are not so much injured by shade as the ash or elm. The maples love fresh, strong mineral soils, such as lime and basalt—in short, such as the beech, but do not bear so much moisture as the ash and elm. The maple grows chiefly on low hilly land and on plains, and extends farther north than the sycamore, which seeks the more mountainous districts, and grows at higher elevations. The sycamore makes greater claims on the soil in mineral strength and moisture than the maple. In dry exposed situations, or very near the sea, neither of the maples shows a lively growth.

The Elm has always been highly prized on account of the fine color and texture of the wood, and its durability when exposed to the atmosphere. Like the oak, this tree has a tap-root, requiring a deep soil, not too binding. It prefers a moist situation, but does not thrive in marshy districts. Lime, basalt, greenstone, loam, and the better kinds of sand, with a plentiful admixture of humus, are the soils best adapted for the elm. It is little suited for pure forests; grows well as standards, and on rich soil bears the shade of standards fairly and shoots well from the stool, although the power of reproduction soon gradually diminishes. Along streams and in moist situations, elms are frequently pollarded for the production of timber prized for cabinet-making, &c., the knots in pollard timber being due to numerous arrested adventitious buds.

Mixed forests of beech, ash, maple, and elm are found to thrive well, and yield a larger revenue than either of them alone, and rules for their cultivation and renewal are laid down in detail.

Hornbeam (*Carpinus betulus*), like the beech, is chiefly used for fuel in Germany, and is seldom allowed to attain large dimensions. From its hardness of wood, it is more difficult to work, but gives more heat than beech, and in sawing and cutting, tools lose their edge very soon. It is used for cogs, screws, ax-handles, joiners' tools, shoe-lasts, and the like. It is often regarded by the forester as an enemy, and, when once it has gained a footing, it is tenacious of life. It steals into beech and oak forests, especially when growing in fresh, humus soils, and prefers the fertile plains and undulating hill-sides to the higher mountain-tops. It is the hardiest of hard woods, and will withstand late frosts, damages from gnawing animals, and other injuries wonderfully well if fairly rooted. Its average life is eighty years.

In general, the effect which the soil and subsoil have on the quality of timber may be expressed shortly but scientifically as follows: The *combustible tissues* of timber, or those liable to decay by exposure to atmospheric or other agencies, are, *carbon*, *oxygen*, *hydrogen*, and *nitrogen*. The absolutely necessary constituents of the *ashes*, or portions not liable to decay, are *iron*, *calcium*, *potassium*, and *sodium;* along with these are often to be found *magnesium*, *manganese*, *silicon*, *sulphur*, and *phos-*

phorus. It follows, then, that according as the percentage of combustible tissue exceeds that of the incombustible the timber will be less durable, and hence, for technical purposes, of less value. Therefore, soils and subsoils in which there is a fair amount of lime, potassium, silica, &c.—in short, those *rich in alkalies*, produce timber of the best quality, while such as contain an overabundance of moisture yield timber neither of such durability nor of so high value.

PLANTING OF THE ASH.

Mr. J. L. Budd, now of Ames, Iowa, in a paper published in the Transactions of the Northern Illinois Horticultural Society (1867–'68, p. 72), advises keeping the seeds of the ash through the winter in kegs or boxes, mixed with clean moist sand, taking care that they become neither too wet nor too dry. Freezing will do no harm. The ground should be marked and prepared as for corn, and planted at the intersections, placing four to six seeds in a hill. They should be carefully cultivated, and the next spring thinned to one plant in each hill, the vacancies being supplied. By planting thus thickly, the young trees get a straight growth. At the end of six years, every alternate row north and south should be thinned out, and at the end of ten years every alternate tree in each row. When twelve years old, on good soil and with proper culture the first four years, the grove would have 12,000 trees on 10 acres, averaging 8 inches in diameter. By cutting the stump close to the ground, and covering with a light furrow on each side, a second growth is obtained in eight or ten years, more valuable than the first.

Prof. C. S. Sargent, in speaking of this timber, says:[1]

To develop its best qualities the white ash should be planted in a cool, deep, moist, but well-drained soil, where it will make a rapid growth. That the plantation may be as early profitable as possible, the young trees should be inserted in rows three feet apart, the plants being two feet apart in the rows. This would give 7,260 plants to the acre, which should be gradually thinned until 108 trees are left standing, twenty feet apart each way. The first thinning, which might be made at the end of ten years, would give 4,000 hoop-poles, which at present price would be worth $400.

The remaining thinnings, made at different periods up to twenty-five or thirty years, would produce some three thousand trees more, worth at least three times as much as the first thinnings. Such cuttings would pay all the expenses of planting, the care of the plantation and the interest on the capital invested, and would leave the land covered with trees capable of being turned into money at a moment's notice, or whose value would increase for a hundred years, making no mean inheritance for the descendants of a Massachusetts farmer. The planting of the white ash as a shade and roadside tree is especially recommended, and for that purpose it ranks, among our native trees, next to the sugar-maple.

THE PLANTING OF SAND DUNES.

No application of sylviculture is more important than that of planting on the dunes upon the sea-shore, where, under extraordinary difficulties, a forest growth has in many instances been started and maintained upon drifting sands, and a certain permanent revenue secured from sterile tracts, which, by constant encroachment upon the cultivated country behind them, had done vast injury by burying fertile fields with barren sands. This subject has with us something more than a historical interest, because we have along our coast, as at Cape Cod and other points in Massachusetts, on the shores of Florida, on the Gulf coast, on the whole of the eastern border of Lake Michigan, and at some places on the Pacific coast, tracts of drifting sand that have done local damage,

[1] *Agriculture of Massachusetts*, 1875-'76, p. 268.

and which have been objects of solicitude and expense in arresting their extension and covering their surface with a vegetable growth.

In 1780, M. Brémontier, availing himself, it is said, of a suggestion made by a priest, curate of Mimizon, devised the means of fixing these dunes, and published the memoir below cited,[1] in which the principles involved in their formation were carefully studied, and remedies were suggested. These the experience of nearly a century has fully justified.[2] He undertook, in 1787, under the patronage of government, the planting of maritime pines with great success.

The Code of Dunes in France dates from 13 Messidor, year IX (July 2, 1801), and directs that measures shall be taken for continuing to fix and plant the dunes on the coast of Gascony, beginning with those of La Teste, after the plans presented by citizen Brémontier, engineer in chief. A commission was appointed, consisting of the engineer in chief of the department as president, a forest administrator, and three members from the Society of Sciences, Arts, and Belles-lettres of Bordeaux, section of agriculture, to be appointed by the prefect upon nomination of the society. This commission was to direct and supervise the work and disburse the funds set apart for this object. In 1808 a similar commission was appointed for the department of Landes. In 1810 another decree was issued for the preparation of plans by the engineers of the *Ponts et Chaussées*, for the fixing and planting of all dunes in the maritime departments wherever they existed, and in case they were the property of communes or of individuals who were unable or unwilling to execute the works ordered, then the expenses were to be undertaken by the State, who reserved all the profits from cuttings or other income until the expenses were recovered with interest, when they were to be returned to the owners with obligation of maintenance of the improvements made. Cuttings of every kind were forbidden on such places unless specially authorized, and provision was made for guarding present and future works of this kind under the same rules that applied to communal forests.

By an ordinance of February 5, 1817, these works in the departments of Gironde and Landes, under the director-general of *Ponts et Chaussées*, under the ministry of the interior, and an annual credit of not less than 90,000 francs was granted for this service; but whenever the plantations were definitely established, their care was assigned to the forest department, the seeds and brush being furnished by the latter.

---

[1] *Memoire sur les Dunes.* By N. T. Brémontier, 1796, p. 74. This is republished in vol. i, 1st series, of *Annales des Ponts et Chaussées* (1833), p. 145. This engineer died in Paris, in August, 1809.

[2] Mr. George B. Emerson, in the second edition of his "*Report on the Trees and Shrubs growing naturally in the Forests of Massachusetts*," i, p. 88, says:

"I visited, in 1872, the region saved by Brémontier, and examined the work he had done, and its effects. The whole country, for more than a hundred miles along the Atlantic coast of Gascony, and from four to eighteen landward, had been covered with sand-hills. * * * The process of ruin had been going on for centuries, and some of the sand-hills were hundreds of feet high. In the midst of this recovered region I stopped a day or two at a beautiful town, where a hundred thousand persons from Paris and other cities of France, attracted by the genial climate and the health-giving atmosphere of the pine forests, had passed the winter. I walked and drove along the sandy roads, visited a monument to Brémontier, erected by his brother, ten miles or more inland in the redeemed territory, and saw in many places deciduous trees—oaks, ashes, beeches, and others—growing luxuriantly under the protection of the pines. One cannot help feeling while enjoying this the justice of our countryman Marsh, who counted Brémontier, and Reventlov, who conducted a similar work in Denmark, as among the greatest benefactors of their race."

Historical information of interest relating to dunes will be found in "*The Earth as Modified by Human Action.*" By Geo. P. Marsh, p. 587–608. Also in a series of articles by M. de Vasselot, in the *Revue des Eaux et Forêts*, 1875.

Finally, by a decree dated April 29, 1862, the whole charge of the works relating to the dunes was assigned to the ministry of finances, and the immediate care to the forest administration, where they now remain.[1]

The amount of sand brought up from the sea every year, and the rate of progression of the dunes inland will depend upon the nature of the coast, the geological formations exposed to attrition, and the direction and force of the prevailing winds. It was the opinion of Brémontier, who executed the first successful planting of dunes on the southwestern coast of France about a century since, that these accumulations of sand were formed less rapidly in earlier times than at present, or they would have produced greater effects, and it is estimated that on this coast the sea delivers about 25 cubic meters of sand annually to a linear meter of shore.[2] On the coast of Southwestern France, between the mouth of the Loire and the Adour, the sea is bordered by dunes which were formerly aggressive, occasioning great loss by actually burying fertile regions and villages with sand, the country still further inland being sterilized from want of shelter from ocean winds.

No planting upon sand dunes can be attempted, nor can it be maintained when once begun, without the protection of a barrier along the shore. This shelter is nothing else than an artificial dune, raised by the wind itself, by placing obstructions in its way that compel the moving sands to settle in the place and manner where they are needed.

In forming a *littoral dune*, a continuous line of paling is first erected parallel to the shore line, and about a hundred yards back from high-water mark. This paling is made of boards about 1.60 meters (4 feet 6 inches) long, from 12 to 15 centimeters (5 to 6 inches) wide, 1¼ inches thick, and sharpened at the lower end. A trench about 15 inches deep is dug, and into this the boards are driven seven or eight inches, so that when the trench is filled up they will stand about a meter out of the ground.[3]

A space an inch wide is left between the boards. The sand is not raised like dust, but generally glides along near the surface, piles up in front of the paling, and, passing through, is deposited behind. The process goes on till the boards are buried, when they are raised one at

---

[1] *Les Codes de la Législation Forestière*, Paris, 1866, pp. 215–220.

[2] Brémontier's estimate was 21½ cubic meters. Laval, from observations made in 1824–'32 (*Anales des Ponts et Chaussées*, 1847, p. 218), estimates it at 25 cubic meters. M. Dutemps du Gris, conservator of forests at Bordeaux, fixes the rate of progression inland at 4.3 meters (14 feet) a year, and the amount brought up is 75 cubic meters to every meter of coast line. (*Supplement to Bagneri's Manual of Sylviculture*, English translation, p. 72.

[3] A primitive idea was to build a solid wall; but this would sooner or later be buriep entirely. A barrier made by a ditch and ridge of earth would serve while it lasted, and hurdles, formed of stakes and brush interwoven, would do service till buried or pressed down by the weight of sand, and might be carried up by repeated additions at the top to a certain distance. A close board fence would cause eddies that would scoop out a hollow in front, until the crest was level with the top of the obstruction, when it would speedily be filled, and the obstruction buried. A paling secured to string-piers, with spaces between, was next tried, and did well till buried; but this could not be raised. Such a fence in sections required too much force to raise; and finally a plain series of separate boards, that might be drawn up singly from time to time, was found best and cheapest. Enough sand passes through to bank up equally on both sides, and the force of the wind is somewhat relieved by the openings that allow it to pass. It is only by oblique currents that a breach might be formed in exposed places.

A row of stakes driven into the sand, with brush woven in between a little way up, and more added as they fill up (the stakes being raised from time to time), has been tried, but found on the whole not so desirable as planks. These vary, according to circumstances, from 1.5 to 2 meters in length.

a time, and the operation is continued.[1] The dune under this management rises higher by degrees and assumes a slope of from 7 to 12 degrees in front, and much less on the land side. Practically, the angle of elevation is best at about 7° above the horizontal in front and 22° in the rear. The wind passing over the barrier strikes down upon the opposite side, and, hollowing out the sand somewhat, passes off, with its force practically broken. The front slope may be concave in some degree. As soon as the paling is set, they begin to plant tufts of *Arundo arenaria* in front, and in a belt eight times wider than the obstacle opposed. These tufts are in quincunx order, and closer together near the paling. The outside of these stop some of the sand, those farther up stop more, and thus an even slope of the desired angle is secured and maintained. This plant is set in winter, and they sow between them the seeds of the same and of *Triticum junecum*, *Artemisia*, *Kakile maritima*, *Salsola*, *Ephedra*, and other maritime plants. Sometimes brush are set in the sand, which answers a good purpose. When the dune has raised some 12 meters in height, it may be widened at the top by substituting for the planks a quadruple row of brush in quincunx, some 15 inches apart. A dune 12 meters high contains 720 cubic meters of sand to each meter, running measure, and, where the sand comes in at the rate of 25 cubic meters a year, would be 30 years in forming. The increase is then about 12 inches a year, a rate of growth which the tamarisk will support, and this shrub may then be planted on the top. The slope should not be raised more than 12° in front, and it is sometimes necessary to carry the paling farther back, by setting a new line, the top being first widened by means already mentioned.

Stability and steepness are sometimes secured on the land side by a fence of stakes and woven brush, which must be renewed by adding to the top from time to time. The greatest protection is afforded when the lee side is as steep as the sand will lie. The grass and other plants planted on the front slope grow upward as they are buried, and thus the sand is bound together in a firm net work of fibers. A hectare requires 300 bundles of this plant, weighing about 22 pounds each, besides 13 pounds of seeds.[2] These seeds are sown broadcast, and no covering is required other than comes from treading into the sand as the workmen pass to and fro. A meter of paling costs 2.5 to 3.0 francs (16 to 25 cents per foot), and will last (if made of sap-wood of the maritime pine, and not injected) about five years. Their maintenance costs half a franc a year, and the fencing with stakes and brush costs a third of a franc yearly.

In storms the wind will sometimes make breaches in the littoral dune, which must be repaired by new palings in lines oblique to the main direction, on the steep side, until the sand piles up to fill them. An irrup-

---

[1] A rude and expensive way of raising, first tried, was by digging away the sand till the boards could be raised by hand, when they were planted anew. This softened the sand and made it liable to be scooped out by eddies of wind. They next tried a lever, placing a chain around the plank to be raised and using the top of the next adjoining one as a fulcrum. By raising a little at a time and getting a new hold they could thus slowly raise them to the desired height. By carrying movable supports along and raising by levers on opposite sides, using four to eight men for the service, the same could be effected. A movable windlass slid along on the sands was an improvement, because the traction was vertical; but finally a movable frame with a long lever mounted on runners that could be slid along the fence to be raised, with pincers and chain, was found to operate with the best advantage. The chain passed over an arc of a circle, near the head of the lever, and thus drew vertically. It is easily carried, and may be worked by one man.

[2] Equal to 121 bundles of the plant and 5.2 pounds of seed to the acre.

tion of sand has been known to form mounds 100[1] meters high, burying hills of half this height, and trees that grew upon their summit.[2]

When this protecting dune has been well established the task of planting the sands under its shelter is begun, and continued until all the sands in the rear, perhaps a dozen miles wide, are brought under forest cultivation. From the extremely light and arid nature of the sand, it would be impossible to transplant trees,[3] and the only chance of success depends upon the possibility of seeding and protecting the young plants until they can take care of themselves. The surface is accordingly sown broadcast with a mixture of seeds of the maritime pine (*Pinus pinaster*), the common broom (*Sarothamus scoparius*), furze (*Ulex nanus*), and beach grass (*Psamma arenaria*). Where the planting is done by the forest administration, the quantity of seed used is 10 kilograms of the pine, 9 of the broom, 4 of the Psamma.[4] The surface, after sowing, is spread over with a covering of broom, furze, and other brushwood, which is brought in bundles and, when spread, is held down by a spadefull of earth thrown on at intervals of about twenty inches. This covering is essential for preventing the seeds from being blown away by the wind, and some fertility is given to the soil by its decay. The sowing of the seed and spreading of the brushwood must be done at the same time, and the last row of the covering at the end of a day's work, must be secured by an additional load of earth, to prevent the wind from getting under and scattering, perhaps, the work of several days.

The pines, furze, and broom sprout and come up together, and the tender shoots of the pine grow best when well screened by the other plants. The protection of the brush-wood must be kept in place about four years, and its maintenance constitutes the principal operation during this period.

The littoral dune may in some cases be itself seeded with pine, a new dune being formed still nearer to the sea. But in any event a sheltering dune is indispensable, and its maintenance becomes a permanent object of expense. It will be readily seen that this undertaking is difficult, and that the direct profit consists in the general benefit to the country protected, and the damages from encroaching sands that are prevented, rather than in the value of the lands actually redeemed. The cost is sometimes as much as $40 per acre, as labor is paid in France. But in securing this result incidental advantages are secured beyond the immediate area of the sands stocked with pines. The shallow lagoons and marshes behind the sands gradually become dry, and cultivation becomes possible over wide areas as these become more and more sheltered by the growing forest. Finally, the timber of the plantation becomes a source of profit from its affording resin through a series of years, and then wood; but these are always to be considered as subordinate results, which are not to be sought at the sacrifice of the main object for which the plantation was made.[5]

---

[1] Equal to 327 feet. Laval, cited in an article upon littoral dunes in the *Revue des Eaux et Forêts*, 1875, p. 131.

[2] In the Gironde and La Charente Inférieure the dunes extend 12½ miles inland and are in some places 200 meters high.

[3] As soon as the radicle is developed it begins to strike into the sand for moisture, and it sometimes grows a foot or more in length while the plant above ground is gaining an inch. The capillary attraction of the sand is often quite remarkable, and moisture will be found a little ways down where the surface is as arid as possible.

[4] Equal to 9.4 pounds of pine, 8.36 of broom, and 3.76 of Psamma to the acre.

[5] The forest administration in France has fixed the price at 30 francs per hectare ($2.40 per acre) as the normal revenue of the dunes when planted and brought to full capacity of production. The whole extent of dunes in France that remained to be

Sand dunes in Belgium.—In a communication from the chief engineer in charge of these works, received through the Belgian Legation, dated Bruges, June 4, 1877, we learn the following in reference to the results of planting upon the dunes of Belgium:

Some attempts at planting have been undertaken upon the dunes of our shore between Blankenbergh and Ostend, and at Adinkerke at a place called La Panne. The conifers do not yield a good result, and, after forty years, we find Weymouth pines and the Scotch and Austrian pines scarcely over 0.2 meters (7.9 inches) in diameter, and 4 meters (13 feet) in height. The specimens are gnarled and scrubby, and broken at the top, the winds being too severe on our coast for the development of these species. The alder, poplar, birch, and ash grow to much greater height in the depressions of the dunes, and better in proportion to the humidity of the soil and shelter from the north winds. The oak does not succeed.

The aspen-poplar has been planted with some success upon the dunes at La Panne, upon the estate of M. Bortiere, and this agriculturist proposes to use the sapwood of this tree in the manufacture of paper. He has placed in the International Horticultural Exhibition at Amsterdam (1877) a specimen of the paper, in sheets, obtained from trees four years old raised upon the dunes of La Panne. The plantations of trees upon dunes, by way of experiment, have hitherto been quite limited in extent, the sands on our coast being generally fixed by means of the *opa* (sand-reed) and the *argoussier*. The first of these is planted in tufts of fifteen to twenty stems, in quincunx order, about 15 inches apart, and the months of November, March, and April are found most favorable for this operation. The latter is of the elæagnus family, an indigenous spring shrub with a silvery leaf, with which they make little hedges along the flanks of the dunes, where most exposed to the winds, for the purpose of hindering the movement of the sand.

As for the drainage of our littoral dunes, it is simply done by open trenches, at the lowest places, so that the water may flow into the nearest streams. But at Scheveninge, near the Hague, there are underground conduits, and the water, which is of excellent quality, is used at the capital for domestic purposes.

The dunes on the shores of Holland and Denmark have been an object of care by the government for a long period, reliance being chiefly had to the cultivation of grasses and creeping plants and finally trees, and the exclusion of burrowing and grazing animals.[1] The *Arundo arenaria*, and other species already mentioned, are found to be especially useful in arresting the sands.

The shores of the Baltic are lined with dunes, and attempts to control them date back some centuries; but they were often neglected in troubled times, especially during the thirty years' war. The sands nearest the sea are best fixed by grasses with tracing and sprouting roots, and an approved plan is to plant the *Psamma arenaria*, *Arundo arenaria*, in patches so as to fill squares four meters on a side, in

---

planted in 1876 was 78,515.46 hectares (194,536 acres). In the departments of the North, of La Somme, and of Pas-de-Calais they chiefly belonged to individuals who had undertaken to plant them under a subsidy from the state, consisting chiefly of the seeds of the maritime pine.

In the Landes and the Gironde about 6,000 hectares (14,820 acres) of the sowing had been finished within fifteen years. France draws an annual revenue of about 130,000 francs from the resinous products of the forests of maritime pine in the Gironde and in the Landes. In La Charente-Inférieure and La Vendé the resin, by reason of the climate, no longer pays.

[1] Marsh's "*Earth as Modified by Human Action*," p. 592. He states that Krause enumerates 171 plants native of the coast sands of Prussia, and that Andresen, in Jutland, carries the number to 234.

The Danish Government, toward the close of the last century, organized an efficient system of planting the dunes of Jutland, by which eventually a valuable growth of timber was obtained, and the further spread of the drifts arrested. (*Ib.*, 595.)

The pypgrass (*Erhartha gigantea*) has been found very suitable for planting sands. It shoots along an underground stem many feet, throwing up at intervals of 10 or 12 inches, stalks 2 feet or 30 inches high, from which the tufted seed is blown by the winds, and the production of the plant is extended over loose sands to the leeward. (*Report of Colonial Botanist*, Cape of Good Hope, 1865, *p.* 83–93.)

checker-form,[1] the great lines being parallel or perpendicular to the prevailing winds (northwest). Those further inland are planted with Scotch pines, in dense masses. The plantation costs about $20 an acre, which includes the covering screens of pine brush, briers, or thorn bushes.

The maritime pine will not thrive on this coast, as it requires a milder climate. The Scotch pines for this plan are taken two or three years old, and are taken up with spades of special pattern. The balls of earth on the roots will just fit the holes in the sand, and the process is expensive and uncertain as compared with that of planting the maritime pine, where that can be grown.

Upon Cape Cod and other places on our own coast exposed to injury from drifting sands, the beach grass (*Calamagrostis arenaria*) has been planted with success, and the government has expended considerable sums for this object. The planting of grass on the dunes of Cape Cod is, however, of no recent date, having been practiced since Colonial days.[2] Similar conservative measures were ordered by law, upon the beaches of Long Island, as early as 1758.[3]

Quite extensive plantations of pine, mostly the native pitch pine (*Pinus rigida*), have been made on Cape Cod and the islands of Nantucket and Martha's Vineyard, in Massachusetts, in very bleak situations, and with considerable success. They have not been planted upon dunes, but on the tertiary and boulder drift that occurs in these places. On the inside slope of dunes in Provincetown, Cape Cod, small patches of the native pine sometimes occur which have been almost buried in the sands, because the summits and weather slopes were entirely unprotected by vegetation.

Upon this coast some of the European pines have been found to thrive better than the native species. The Scotch, Austrian, and Corsican pines in particular do well, while the Norway spruce fails. The southwest winds on this coast in spring and autumn in force and regularity amount almost in these respects to the trade winds, and are very trying to sea-side tree-culture.

On the Florida coast, the Bermuda grass (*Cynodon dactylon*) has been

---

[1] Experiments have been made by officers of the United States Engineers, in transplanting sods from a marsh to the sands adjacent, in the improvements undertaken on Cape Cod, Mass. The sods, 6 inches square, were imbedded in the sand in rows 2 feet apart, and 2 feet apart in the rows. The report of 1876 shows that 10.000 sods had been transplanted, and in most cases promised good results. The trial was, however, too recent and too limited to judge of the results.

The planting of beach grass was, however, considered the most economical and effectual means that had been tried for securing loose sand. (*Report of the Chief of Engineers*, 1876, *Part I, p.* 188.)

[2] Dr. Dwight, in his travels (iii, p. 93), mentions a case where a beach was planted with the grass above named, raising a dune so as to close a breach made by the sea. In another instance he records great mischief from pasturing the beach grass, which allowed a thousand acres or more to be blown away in many places to a depth of ten feet. "Not a green thing was visible except the whortleberries, which tufted a few lonely hillocks, rising to the height of the original surface, and prevented by this defense from being blown away also." (*Ib.* p. 101.)

Professor Hitchcock mentions extensive plantings of beach grass, and observed that two species of the Hudsonia, growing wild here, present no small obstacle to the sands, although not transplanted for this use. (*Geological Report*, 1833, p. 130.)

The beach grass above mentioned grows in tufts of long fine leaves, standing upright, and when planted some 20 inches apart soon gives good protection. This grass has the peculiarity of rising or growing through or above any ordinary sand-drift, sometimes rising eight or ten feet above the original roots, though its ordinary height is but 12 to 20 inches.

[3] "An act to restrain the feeding and burning the grass and cutting the timber on certain beaches and islands therein mentioned," passed December 16, 1758. Renewed repeatedly in Colonial times, and by State law in 1789.

successfully used in fixing loose sands, and serves the purpose admirably. Its roots creep to a great distance, with short, flattish leaves, sending up flowering shoots a few inches high at intervals, which bear seed and spread. An officer of the engineer service who has had experience with this plant at Saint Augustine, Fla., describes it as running over the sand in zig-zag form, with joints at each angle six or eight inches apart, from each of which a root strikes into the ground, soon forming a very successful network of roots through the loosest sand.

In the vicinity of Key West, and as far north as Jupiter Inlet, the cocoa-nut tree is said to offer an excellent protection to the sands on the shore. It was introduced about 1840, by the wrecking of a vessel that threw a quantity of the nuts upon the beach, where they sprouted and grew. Some of these trees bear fruit and are forty feet high.

As already remarked, the eastern shore of Lake Michigan is bordered by sand dunes, a considerable part of which have been covered with forest vegetation by a natural process of seeding, while in other places they are drifting sands. At Michigan City they are 165 feet high, and near Grand Haven still higher. At the latter place a railroad station on the north side of the harbor has been abandoned by reason of these sands, and buildings have been buried.

Serious inconvenience has also been experienced on the south side of the river, where mounds of drifting sands have entered the border of the town. A feeble attempt was made to arrest this damage by placing a board fence on the *inland slope*, which, of course, afforded but slight temporary protection. A thorough remedy would doubtless be found by planting the outside sand-flat which has formed by the piers at the mouth of the harbor, with willows or other trees, and by sowing and covering with brush, beginning on the lake side where the drift *begins*, and extending up the hill and thence down over the slope.

The wooded sand hills adjacent abundantly indicate the species that would thrive in this soil, and would furnish the seed by which the planting could be executed.[1] But there is especially needed a State law in Michigan strictly forbidding the clearing of timber on these sand hills adjoining the shore, without regard to owners, and as a measure of public protection. Discretion might be given to Boards of Supervisors for regulating the application of such a law, but not for suspending its effect.

Much of this shore has, on the land side of the dunes, a series of ponds and marshes, occasioned by obstructions to the mouths of rivers and streams. The region adjacent to the lake has been found extremely well adapted to the cultivation of fruits from the equalization of temperature which this body of water secures, and the check which it holds upon the premature opening of buds in the early spring.

The Chinquapin (*Castanea pumila*) and the chinquapin-oak (*Quercus prinoides*) are well known to be adapted to sterile lands, and are found to succeed on arid plains in France and Germany. M. Bouché, inspector of the botanical gardens at Berlin, in a paper read before the Society of Acclimatation in that city, specifies these as possessing the additional merit, besides growing where many other trees and shrubs would perish, that they afford an abundance of fruit for feeding swine.

At Monticello, near Charlottesville, Va., and its vicinity, the furze (*Ulex Europea*) is now growing abundantly, having been introduced by

[1] The wild grape appears to thrive very well in these sands, and might doubtless be planted with great advantage. The *Calamagrostis arenaria* and *C. longifolia* thrive in the sands of Lake Michigan shore, affording an excellent means for giving them stability where there is occasion.

Mr. Jefferson, as adapted to stony and sterile soils, preparing them for something better by supplying the organic elements needed for their growth.

THE TRANSPLANTING OF LARGE TREES.

The art of transplanting large trees was known to the ancient Romans,[1] and the display of power and resources implied in the successful transplanting has often led rulers to indulge in this fancy, and, often at vast expense, the removal of a full-grown tree being even more striking in its effect upon the popular mind than that of heavy monoliths, because it implies a conquest over nature, and against all common experience.[2] About sixty years ago Sir Henry Steuart, of Allenton House, Scotland, did some very successful transplanting on his estate, transforming an unimproved ground into a charming woodland landscape, anticipating the natural growth of timber for a life-time, and this at a cost of not over £30 per acre.[3] His success depended mainly on the care which he bestowed in preparing the roots of the tree before removal, and the delicacy with which these important parts were treated in the operation.

He remarks that the amount of roots and their fibers is always greater in open situations, and that they extend wider from the plant, not only to enable it to resist the elements, but to provide sustenance for the relatively great amount of foliage which trees thus exposed to light and air usually bear. In such trees the roots are generally longest and strongest on the side toward the prevailing winds. He notices a certain resemblance between the branches and the roots, in this, that while the tree is young and growing, but before it reaches its ultimate height, it has a leading shoot, and a tap-root; but that when it gets to its full height, the head becomes more bushy, and the tap-root loses its relative importance, so that when an old tree is overthrown, it can scarcely be found. The form of the roots is also materially determined by the soil, being spare and scraggy in stiff, poor soils, and very luxuriant in those that are mellow and deep, allowing the fibers to expand and elongate with facility.

To prepare a tree for removal, these rootlets or fibers should be multiplied as much as possible, and this result be accomplished by spreading a peat compost, prepared with one-third part of animal manure, finely decomposed and mixed with soil, over the roots of the tree three or four years before it is to be removed. Into this loose friable mold the genial rains would readily enter, and the fibrous roots shooting up would pervade the mass, giving it a vigorous growth, so as to better endure the ordeal through which it is to pass. A trench is also dug around the tree at a distance of three feet and a half, if it is to stand four years, but six or seven feet, if it is to stand two years;[4] but no tree should

[1] Virgil celebrates the skill of an old Corcyrian who transplanted into rows the far-grown elm, &c. (Georgics, iv, 144.)

[2] Sir John Evelyn in his Sylva (i, 103), mentions remarkable instances of successful transplanting on a large scale. The most noted patron of this art was Louis XIV of France, and some of the trees removed by his engineer, Le Notre, are said to still exist. The machines used in their removal were destroyed in the French Revolution, and as to his methods we have no account.

[3] Mr. Steuart published his method in a book entitled, "The Planter's Guide; or a practical Essay on the best method of giving immediate effect to Wood, by the removal of large Trees." * * * * 1832, p. 422. An American edition was printed at New York by Grant Thorburn and Sons.

[4] The rule laid down by Brown is, that the trench should be generally made at about two-thirds of the distance of the natural spread of the branches, as at this distance the roots have ramified so as to be of small size, and within this there are sufficient fibrous roots to insure success. (*Brown's Forester*, 4th edition, p. 719.) It is further

be taken up on a single year's growth after cutting around. The trench should be dug down to the subsoil, or at least below the roots, and if liable to hold water a drain should be dug from it on the lower side. The principal roots on the side toward the prevailing wind are however not cut off, and when the tree is finally removed these are carefully saved for a considerable distance. The trench is then filled with the same soil, finely broken and mixed with a little compost, and is thus left from two to four years to multiply its fibrous roots as much as it will.

When the time comes for removal, the trench is again opened, the tree carefully undermined all around with a pick, so as to remove the soil without injuring the fibers, and finally pulled over, not all at once, but alternately back and forth, soil being thrown under the open side at each time, until the roots are all detached, and the whole tree raised above the original level. It is then turned over so as to balance on an axle of a cart, cushioned to prevent injury to the bark, and provided with a long pole upon which the top of the tree rests. It is drawn to the place intended root foremost. As much of the soil near the tree as can be saved is kept with the root, and care is taken at every stage of the process to prevent injury to the roots, trunk, or branches.[1]

The tree thus removed is placed in pits ready prepared, with compost and finely divided soil, and the fibers carefully spread out, and covered with soil fitted for their immediate use, the long bracing roots being especially cared for, and placed in the same relative position as before.[2]

But it is an *expensive process* at best, wholly out of the question in forest culture, and only to be attempted in cases where a public park is to be created without regard to cost, or private grounds are to be improved by an owner with ample means.[3]

---

recommended that the roots when cut should be smoothly pared off, that the loose soil where there are no roots should be picked out for some little distance, and replaced by rich vegetable mold, into which the fibers will strike more readily and abundantly. In a heavy clay soil the preparation should be made at least three years before removal. The soil that is put into the trench should be dampened from time to time, and the tree should be stayed if liable to be overturned by the winds.—(*Pépinières: by Carrière*, p. 118.)

[1] The custom of preparing large trees for transplanting by digging a trench and cutting off the principal roots, including the tap-root, but still retaining some connection with the soil, and filling in rich mold for the development of fibrous roots previous to transplanting, appears to have been introduced by Lord Fitzharding, a cotemporary of Evelyn, in the time of Charles II. He did not, however, try his skill on trees larger than 26 or 28 inches in girth.—(*Steuart's Planter's Guide*, p. 67.)

[2] It was remarked by Mr. A. J. Downing, the eminent American landscape gardener, that in transplanting trees "the perspiration is governed by the amount of sunshine and dry air—the more of these the greater the demand made for moisture on the roots. * * * In England, therefore, it is much easier to transplant large trees than on the continent or in this country." He considers Mr. Steuart's method very difficult of application in our dry atmosphere and brighter skies. The trees start into leaf, and all promises well; but unless under very favorable circumstances, the leaves beggar the roots, by their demands for more sap, before August is half over.—(*Rural Essays*, p. 345.)

[3] The extent to which this has been done with good results, may be judged from a statement made in the Tenth Report on the Brooklyn City Parks, where it is said that between 500 and 600 trees, ranging from 4 to 17 inches in diameter at a yard from the ground, and weighing as high as 15 tons, have been removed with such success that but six had died. The same machine, or one on the same principle, has since been used on the public grounds at Washington, and is shown in the accompanying engraving. It is claimed that it operates with more ease and certainty than others so extensively used in Paris and elsewhere.

A tree-lifter, described by Col. George Greenwood, an English writer, consists of a pair of flat, strong wheels, with a round iron-axle three inches in diameter, to which chains may be fastened by hooks. This axle may be turned by smaller wheels on the outside, and having handles like the steering-wheel of a vessel. It thus becomes a kind

In northern climates the transplanting of fruit and forest trees may be done with great certainty and success, by digging a trench three or four

Machine used in Brooklyn and at Washington for transplanting large trees.

feet from the trunk of the tree, and to some depth below the roots in the fall of the year, taking care that the trench is properly drained of stand-

of windlass on wheels. When used, the machine is brought over the roots, which have been carefully bound with canvas, retaining all the fibers and soil that can be saved in contact with them, and chains are passed under and around the ball. The tree is then raised by turning the windlass, and the axle is fastened by a cord passing from the handles to a hook on the shafts. The wheels should be supported upon planks, and one side of the excavation should be graded down so that the machine will pass up the inclined plane. A similar slope is made on one side of the hole where the tree is to be placed.—(*The Tree-Lifter, or New Method of Transplanting Forest Trees.* By Col. George Greenwood. London. 3d ed., 1876, p. 235.)

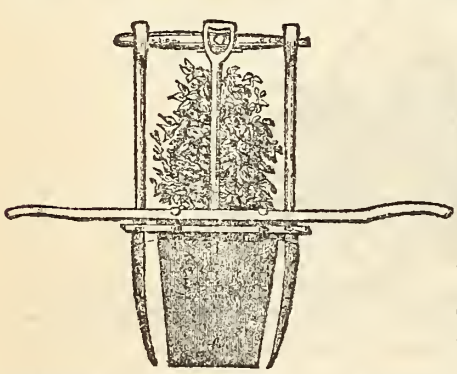
ing water. When the disk of earth inclosing the soil has been frozen into a solid mass, it may be pried up without disturbing the roots, and the whole removed to a new site with no greater difficulties than those encountered in handling without injury. This method is, of course, not adapted to general planting, but is limited to special cases, where the distance is not great, and the circumstances are favorable.

It is the practice of some to carefully pass under the ball when a little raised, a sheet of stout coarse canvas, which is then bound firmly with ropes around the roots and the included soil to keep the small fibers from the air, and the native soil as much as possible in contact.

Carrière[1] recommends surrounding the ball of earth (which should be smaller below than above), with hurdles, branches of trees, boards, or simply layers of straw, strongly binding with cords. It would be still better in some cases, to have a basket-work woven for this use, by a basket-maker, so as to fit the ball, and of strength proportioned to need. The bark of the tree should be securely wrapped, wherever ropes are to be fastened or force applied. In raising very large trees, three poles or pieces of timber, fastened together at the top, would give support to the pulleys used for hoisting it high enough for placing upon vehicle. The hole to receive the tree should of course be suited in form and depth, and the sides should be loosened with a pick, after the tree is placed, as they would be apt to become hard-pressed in the operation. The packing is then carefully removed, the tree suitably supported, rich soil is carefully filled in, a thorough watering is applied, and the ground covered with litter to prevent drying. With respect to the season when this should be done, Carrière, writing for the practice in France (comparable with the middle latitudes of the United States), says:[2]

> We should as much as possible execute these labors in winter, when there is no snow, and the ground not too wet, because, aside from the facility with which it can be done, the transportation is favored by the ice, which affords a better chance of success. When the ball is prepared and wet the night before, freezing will turn the whole into a solid mass, which can be moved with great certainty, and when the tree is not extremely large often without coverings for the roots. It is moreover evident that this operation should not be tried unless the tree is hardy, and that it should never be attempted where the roots might be injured by the frost.

A simple contrivance, consisting of four spades, a frame for holding them together, and cross-bars for spreading the handles, was described by Mr. MacGlashen, in the *Revue Horticole*, 1853, p. 455, and is worthy of notice. It can best be illustrated by an engraving. A square frame being placed on the ground around the tree or plant to be moved, four spades, with holes in the handles, are pressed vertically down, and their handles spread as much as possible apart, and fastened on the cross-bars by pins. The projecting ends of the square frame serve as handles for raising and carrying the plant and compressed soil inclosed between the blades of the spades, with very slight disturbance of the roots.[3]



Four-spade arrangement for removing the soil with roots of trees.

[1] *Pépinières*, p. 118.

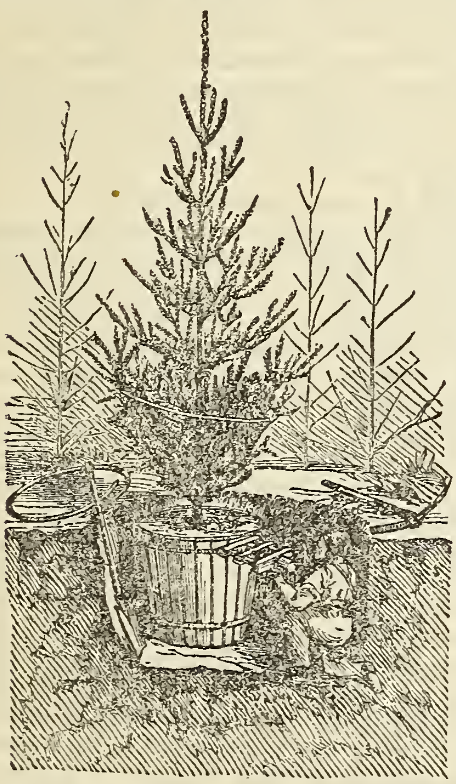
[2] *Ib.*, 122.

[3] This device works extremely well in cases where the tree is small, but in models that have been made for those of larger size, with eight spades of proper size and strength, two on each side of the square, the expense and inconvenience become greater than the advantages. In large models that have been made, the handles of the spades were long and solid, bound with iron rings at the end, so as to bear driv-

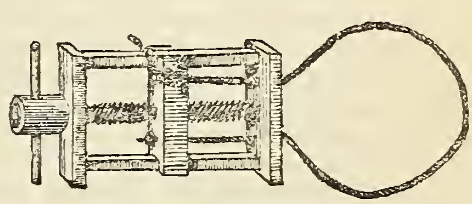
It is needless to remark that in the transplanting of deciduous trees, the removal should be done during the suspension of active vegetation, that is, from October to April, and generally in the spring before the leaves begin to appear. The pits for receiving the trees should be dug a little time before, if the soil is good, and several months before, if of inferior quality; and it always tends to secure success in poor soils to place an abundance of fertile vegetable mold.[1]

ing deep into the soil, and movable sockets were placed to receive the pressure of screws for spreading apart the tops of the spade-handles. If too large to be carried by men, the apparatus was mounted upon wheels, with a windlass for lifting and supporting it by chains. The machine, consisting of four spades, is most effectual in its simplest form, and for small trees. Its application becomes more difficult as the size of the trees becomes larger, and very soon reaches the maximum limit of application, because large trees must have a much wider ball of earth than it can raise, and in stony soils it is altogether useless in any form, and if the soil approaches the condition of dry sand, the contents would more or less escape, notwithstanding the compression.

Another method is here shown, which needs no explanation beyond that afforded by the engravings. It is adopted in the city of Paris for the removal of evergreen trees, which are taken from the Bois de Boulogne and Vincennes. In first placing the staves, a space of three-fourths of an inch is allowed between each, so as to admit of some compression without bringing them in contact. When fully compressed, barrel-hoops are put around and nailed, so that the roots are inclosed, as it were, in a cask, and the whole may be raised and carried without the least risk of injury to the growing tree. This cut is reduced from one in Kirwan's *Conifères*, where it is credited to an article by M. André, in the journal *La Ferme*.



Mode of transplanting practiced in the nurseries near Paris.



Screw-clamp for binding the staves around the soil.

[1] M. Dupuis, in writing for the conditions found in France, says:

"In general, in a northern climate we would find it of advantage to dig the holes in autumn for the trees that are to be set at the end of winter. The dimensions will vary, but for trees of mean size two meters square and one deep will be sufficient. In this operation we should put separately on three sides of the hole the turf, the first mellow soil, and the earth from the bottom. Sometimes the hole is dug round, but the operation is not so easy, and it should be reserved for rare or precious kinds that need to be planted separately. In setting avenues, some prefer to dig a trench about a meter in width, dividing the earth into two parts and placing it on the two sides. In dry soils, warm climates, and for rustic deciduous trees, autumnal planting is preferable. In humid soils, in cold climates, and for the delicate or evergreen kinds, it should be done toward the close of winter or at the beginning of spring. When the proper time comes the tree should be raised with care, so as to preserve as many of the roots as possible, and it should be carried to the place it is to occupy with as little exposure of the roots to drying as possible. The ends of the roots should be smoothly cut where mutilated, and we should at the same time suppress some of the lateral branches—sparing the head if possible.

"In proceeding to plant, we begin by spreading over the bottom of the hole several inches of the upper soil. The tree is then set upright and the roots are spread apart, so as to lie in a natural position, and the rest of the surface soil is scattered in. When good soil can be got, especially such as is thrown out in the cleaning of ditches or water-courses, it would be well to spread this in the bottom of the hole. The middle layer of soil is then scattered in, the tree being lightly moved up and down in a ver-

CHANGES IN TREES BY REMOVAL TO OTHER LOCALITIES.

Dr. C. C. Parry, of Davenport, Iowa, to whom science is indebted for many useful observations in botany, has remarked[1] the extreme slowness and apparent frequent failure in the introduction of new and desirable forms from the domain of native botany to horticulture, the best results being the accumulation of ages of laborious experiment, in which adaptation has had time and opportunity for working out the desired results. As an illustration of the results that may follow the removal of trees from their native locality, leading to unexpected success or disappointment, he cites an illustration from his own experience:

In 1862, while engaged in making botanical explorations in the high alpine districts of the Rocky Mountains, I made my first collection of conifer seeds for distribution, including, besides rare and new species, others well known from early California collections. In sending off my collections (mainly to Europe), I naturally called special attention to such as were new and rare, but at the same time sent a collection of all. In due time the seeds were planted in widely remote localities, where it would be impossible to trace them out, but a few of each kind were retained by Professor Gray, at Cambridge, Mass., and there sown. It seems that by some accident in transplanting the names were misplaced, and eventually lost, so that many years after on a visit, I was requested to examine the different plants, and name the species as well as I could from what I knew of them in their native haunts in the Rocky Mountains. Of course, there was no difficulty with reference to the Douglas spruce, which had been readily recognized from its characteristic foliage, but the striking difference which the tree from the Rocky Mountain seed exhibited by the side of the same identical species from California was apparent as far as they could be seen. The former, thrifty, with bright green foliage, then just putting forth its early summer shoots; the other, with blighted branches, brown, faded leaves, and general decrepit growth. Another species to which my attention was directed, was justly regarded by its owner as the prince of the lawn, presenting a symmetrical cone of dense foliage, covered with a peculiar bluish-silvery bloom, indicating, in the abundance of *stomata*, an unusual vigor of growth. In this, also, I had no difficulty in recognizing an old familar acquaintance, the Menzies spruce. The other species of spruce, or pine, on which I had laid so much stress and built so many horticultural hopes, had been overlooked, or proved failures; but I was urgently advised, in future collections, to give special attention and collect copiously of these common kinds which, two thousand miles from their native habitation, had developed such remarkable horticultural value. In view of such facts, I should be very reluctant to adopt or sanction an opinion that has recently been expressed in discussion before this society, that for ornamental evergreens in Iowa we must be contented with the stiff forms of the Norway spruce, or the unsymmetrical Scotch or Austrian pine. However desirable these may be in their proper sphere, and especially as adapted by long culture to horticultural conditions, we may certainly hope, eventually, to find something more graceful, more symmetrical, and densely foliaged, to grace our ornamental lawns, or act as wind-breaks to soften the force of our fierce winter winds. Whether these desirable acquisitions are to come from our own adjacent mountains or from far Cathay, they must and will be eventually secured.

TRIMMING OF FOREST TREES—REPAIR OF INJURIES.

Trees left to themselves, successively lose their lower branches as they grow in height, by a natural process of dying out and dropping off, until they reach a certain height, which does not differ greatly in a given species under like circumstances, but is much greater in a dense forest than where freely exposed to the sun in the open air.

---

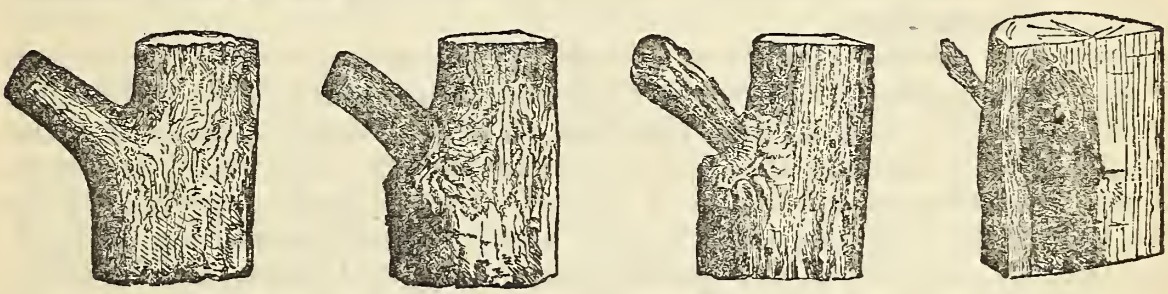
tical direction, so as to work the soil in among the roots, and vacant places may be filled up by crowding with the hand. So, also, when we plant a ball of earth with the roots, the little interstices between this and the sides of the hole should all be carefully filled. Finally, we fill in the remainder with the soil taken from the bottom, pressing it down, and somewhat heaping it up. Thus we reverse the order in which the soil was taken out. In planting in a trench, we observe the same order; but when setting trees with opposite branches such as the maple, ash, horsechestnut, and the like, it is well to place the trees so that the principal branches shall be parallel or transverse to the line of the trench."—(*Arbres d'Ornement de Pleine Terre*, p. 143.)

[1] Report on Botany in its Relations to Horticulture; *Iowa Hort. Report*, 1876, p. 167.

From time immemorial, it has been known that good results will often be obtained without the slightest intervention of man, as we observe in our native forests; but it is equally certain that, by judicious trimming and timely attention to defects in growth, a much more uniform and profitable result may be obtained and needless losses avoided.

This attention is more especially desirable in the case of ornamental planting, in which generally more time and expense can be afforded than in the larger way, where whole forests require attention, and the cost of labor is an item that must be carefully regulated, so as to be kept within the limits allowable in the general result.

Nothing is more common than to find in forest trees great injuries to timber in the form of rotten cavities, often extending to the root, which began by the breaking or cutting off of large branches, or that have been caused by a dead branch remaining on until it finally drops, leaving a pipe for admitting the rains into the heart of the tree, and finally destroying it altogether. The stages of this process are well exhibited in the following illustrations:

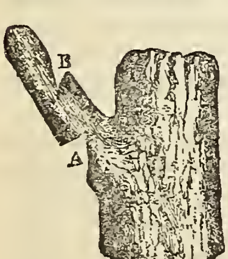


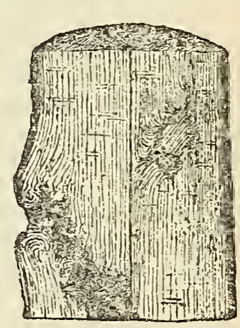
At first. *In 5 years.* *In 10 years.* *In 15 years.*

Stages of decay in a branch of Oak partly left in trimming.

The loose knots in sawed timber, afford familiar examples of the injuries that may follow when limbs remain upon the tree after they are dead, and wherever woodlands receive proper attention these cases require the notice of the forester, and become real subjects of surgery.

The principal objectof forestry being to raise the largest amount of wood of the greatest value upon a given area of land, it becomes important not only to give attention to such accidents and injuries as may happen, but to prevent at times a tendency to vicious growth, or the formation of large branches too near the ground, and especially in trees planted for ornament, where symmetry of form is an object worthy of attention, and may be secured by a little timely care. In young trees the growth may sometimes be thrown into particular branches by cutting off the ends of others, still leaving the principal foliage for the use of the tree, and without sensibly checking its general growth. When large branches are cut or sawed first on the upper side, they are apt to tear down the bark and wood on the under side when they fall. The cutting should therefore be commenced below, as shown in the annexed cut, in which the incision A is first made, and afterward that at B. When finished, the incision should be perfectly smooth, and as vertical as may be. Such a surface will heal over much better than a rough one, and the soundness of the wood at the place of amputation may be secured by a coat of paint or coal-tar, until the injury is repaired. It is true that the new wood will not unite with the old, but





A well-healed and a badly-healed wound in timber.

there will be perfect contact, and the timber in the end will be much more valuable than if a rotten cavity was left, instead of a mere line of division between the old and the new, which would be less extensive and much less injurious than the cracks that appear in timber when too rapidly seasoned. It is only in very exceptional cases of construction that a piece of timber would be thrown out as unfit for use because it showed well-healed scars from an old wound.[1]

The most important objection raised against the trimming of evergreens is their tendency to the exudation of resinous matter, which, in the Scotch fir and larch, will sometimes destroy the tree altogether.[2] The exudation may go on slowly, and seem to be stopped from time to time, according to the season of the year and the activity of the vital process, but it reappears with warm weather, and will continue to resist any application that may be made to prevent it. A mixture of tar and grease, or coal-tar alone, has been sometimes successfully applied, but in other cases nothing can be applied that will thoroughly staunch such a flow when once established. A dead branch may be cut off whenever found, without injury.

The most effectual mode of correcting a tendency to unsymmetrical or distorted growth of young evergreens in nurseries, is doubtless the "disbudding" or taking out the bud, thus seasonably preventing the irregularities of growth that, if left to themselves, they would occasion. Thus a superfluous leader, or a branch of inordinate growth, may be checked while the plant is still small, and a normal growth maintained. The time of year when this remedy may be applied appears to be of little consequence, and the fault may be remedied whenever seen; for it is a rule without an exception, that a tendency to vicious growth early seen and corrected is better than its cure at a later stage, however successful it may be.

When young thickets, designed for timber, are thinned out while young, say from ten to fifteen years after sowing or planting, the trunks of the trees left as reserves are often too slender in proportion to their tops. In this case it is recommended that they should be bent over, and the ends of the branches trimmed off, in such a manner that the head may be well balanced and the amount of foliage in some degree proportioned to the size of the stem and roots. When the leader or main central shoot is broken or dead, an adjacent branch may sometimes be bent up and tied to it until it acquires an upright growth, so as finally

[1] It should always be borne in mind that the amount of wood-growth in a tree depends upon the extent to which the nutritious elements of the soil and air are elaborated and prepared by the leaves, and that, in reducing their amount by trimming, to that extent do we lessen the productive forces of the tree, and for the time being reduce the amount of annual gain for the next and several succeeding years, until a proper balance is secured by a new supply of leaves. Experiments have been made by carefully cutting and weighing the trunk and branches of trees in similar conditions except as to trimming, and at various intervals afterward, the result showing that the amount of wood-growth was diminished in proportion to the extent of trimming done. But in the final result there can be no doubt but that this temporary loss will, under judicious management, be more than compensated in increased after-growth and in the final value of the timber.

[2] The evergreens differ in their ability to bear pruning according to the abundance of resin that they contain, and in some of the pines and piceas, wounds will bleed a long time after the injury. To the question, "Should we prune the resinous conifers?" Carrière answers *No*, if kept for ornament, whether alone or in masses, because in their native condition they are most agreeable to the eye; but *Yes*, if the value of the timber is an object. He especially condemns the practice of leaving pegs in trimming evergreens, and insists, with good reason, upon the necessity of trimming close to the trunk.—(*Traité général des Conifères*, p. 616.)

to take its place. A branch too much inclined from a proper direction may be drawn up by tying to other branches, just as the whole tree in a young orchard, is often corrected from a leaning tendency by tying to stakes. If a cord is not at hand the forester sometimes uses a small branch still attached to the tree as a wythe for tying up a leaning top or irregular branch until it will keep in place without help. These methods are shown in the annexed engravings.[1]

These attentions to details, always important, are too generally neglected, and may be not practicable with us in the case of forests; but sometimes a little reasonable care will, if timely bestowed, prevent a valuable tree from becoming good for nothing.

After trimming the lower branches of a tree, it will be often found that shoots will start out from the edges of the wound, or in other places, which will sometimes, if allowed to remain, take inordinate growth. If not desired, they should be removed by préference the second or third year in August or September, after the wood of the year has been formed.[2] For this purpose various instruments have been de-

[1] A careful attention to the condition of an old tree is not less useful than in the young, the chief anxiety in this case, being to remove dead or dying branches or rotting parts with as little injury as possible, and to protect the wood until it can heal, or if this be hopeless, to exclude air and moisture, and thus prevent or retard further decay. Where a section is too large to admit the hope that it will ever grow over, the life of a tree may be somctimes prolonged by covering the exposed wood with a disk of lead, zinc, or tin, carefully secured around the edges, so as to exclude the air and moisture. In some cases aged trees in parks and private grounds, which are valued on account of historical or family associations, may thus be preserved, and their vigor in some degree renewed.

Whenever a piece of bark has been removed down to the sap-wood, the adhesion cannot be restored, however carefully replaced, and the part exposed loses its vitality, and if left unprotected, tends sooner or later to decay. The living parts adjacent will begin to form new wood, and if the injury be not extensive, they will eventually close over the wound, and in course of time leave no external trace. But if large, the exposed wood tends to decay, and before it has had time to close, a rotten cavity is formed, extending somewhat upward, but chiefly downward in the direction of the vessels of the wood, and sometimes quite into the root.

Although no application, however soon applied, will supply the place of the natural covering, a coat of coal-tar or other paint would afford great protection, and often prevent the rotten cavity from forming, until the wood had united over the injured part.

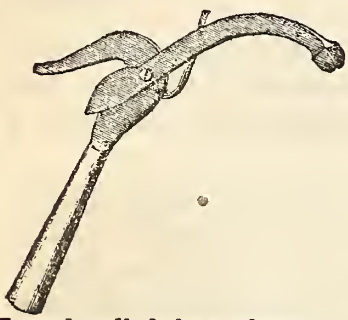
Whenever the bark is loosened, the wood dies under the affected part, the same as though it had been wholly removed, and it is not unfrequently found in orchards and plantations that this loosening of bark has existed for some time without notice, causing a languishing appearance without visible cause. The healing process by overgrowth goes on in such cases as when fully exposed, and the treatment needed is the removal of the dead bark and protection as in case of other wounds.

Such exposed places and rotten cavities are further injurious by harboring insects, and especially those whose larvæ feed upon decaying wood, and through whose agency the destroying process is hastened. The remedy, so far as known, consists in cleaning out the decayed part as fully as possible, applying coal-tar, or other covering, freely to the surface, and, where it is possible, plugging up the orifice with hard wooden wedges or pins, which should be cut close, and be allowed to grow over. Such cavities, if too large for this treatment, may, in old trees, be sometimes hindered from growing larger, by closing them with carefully fitted planks or metal sheets, so as to exclude the air. The borers that infest dead wood might not respect a plank or board which has already lost its vitality, but a sheet of zinc or other metal would afford complete immunity from their attack.

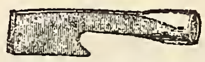
[2] The side branches that spring out where an oak forest is thinned, and the trunks exposed to light, would, if allowed to grow, interrupt the balance of growth, and cause the top to die out. The rule laid down by Lorentz and Parade is, that the pruning of this side-growth should commonly begin three years after the thinning, and be repeated every three years to about half or two-thirds the period of revolution. By this time the younger growth will have come up high enough to hinder further trouble from these branches along the trunk.—*Culture des Bois*, 2d ed., p. 299.

vised for cutting by a stroke or by a cutting edge, on the plan of a chisel, or by a drawing cut, as in a bill-hook, or between cutting-blades, as in the shears, or by a fine-toothed saw. These, except the first, may sometimes be fastened to long handles to great advantage.

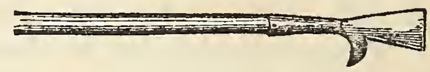
The following cuts represent some of these implements as given in French works. The *serpe* is a heavy cutting tool, usually carried in a sheath on the left side, supported by a strap passing over the right shoulder. In using this tool, the blow should be made from below upward:



Long-handled shears for pruning (French pattern).



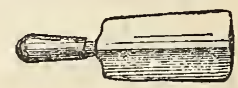
Pruning-chisel.



Chisel and cutting-hook combined.

It is essentially important that the cutting-shears should have a convex and a concave blade,

Hand-shears.



The serpe.

and they work to best advantage when the branch is bent at the moment of cutting, so that the parts may yield as they are separated. The facility with which a branch of green wood an inch and even two inches in diameter may be cut by these shears, when properly managed, is surprising.

With respect to the season of the year when trimming may be done to best advantage, authorities agree quite generally in designating the beginning of autumn, while the days are still pleasant and long, and the condition of growth is least favorable for reproduction. Many kinds of trees would suffer from the bleeding of sap if trimmed late in winter or in spring, and the growth of sprouts around the wound would be troublesome. The action of frost on a fresh wound, in some climates, tends to cause decay, and indicates the winter season as improper for this labor.[1] Where oak timber is grown for use in naval architecture, attention is often given to the future uses of the parts, by encouraging the growth of curved limbs, and sometimes by bending and confining certain branches until they will retain the particular shape desired.[2] This has been done to some extent in forests owned and managed by governments, with the view of supplying the wants of their ship-yards.

In Europe, the wood obtained from trimming trees, more than covers

[1] The *Count des Cars*, whose method of pruning will be more fully noticed on a subsequent page, after mentioning the relative advantages of the different seasons for pruning forest-trees, remarks: "In conclusion, I would say that as for the trees themselves the season of year is of little consequence; the main thing is to trim. But I would advise as a general rule, for woods of considerable extent, to do it from autumn to spring, or from September to June, if you do not work through the year. In some mountainous countries, and generally in France, they trim through the winter, and the work can generally be done except when it rains or snows, or when frosty and icy. At other times the work can always be done to advantage. In the morning, when the branches are slippery, the workmen work from their ladders upon the large branches, rotten spots, and the like, which require most time, and in warm, pleasant weather, on a calm day, they may climb among the branches of the top."—*L'Elagage des Arbres*, p. 82.

[2] Upon this subject, the *Manuel de l'Elageur* of M. Hotten and the writings of Du Hamel du Monceau may be consulted with great advantage. It is observed that the oak seldom bears trimming well, and it is laid down by M. Nanquette as a rule, that it should only be done when found necessary to improve its form, or to prevent the injuries to which it is exposed. Among these is the suppression of gormand branches after thinning and before the undergrowth has come up high enough to shade them out. The lopping off of these branches should be done at the end of the summer, and one or two years after if necessary.—*Exploitation, Debit et Estimation des Bois*, pp. 8–10.

the cost, and sometimes pays a notable profit—the product being cord-wood, very superior charcoal-wood, and fagots, besides (in case of oak) bark used in tanning. The amount of this income, of course, depends upon nearness to market and cost of labor and transportation. In the early years it is nothing, but the rate gains rapidly in the later years.

In some cases (more particularly with poplars and willows) the tops are cut off entirely, with the view of obtaining lower and more sightly shade, or sometimes for the fuel thus obtained. Such trees are called "Pollards," and, if symmetry and beauty are sought, the branches should be cut, as shown in the second of these engravings, a little above and not at the main division of the branches. Such trees will tend to make a graceful head instead of a clumsy and distorted one. The subject will be better understood by reference to the engravings. Where a poplar, for example, has been cut off below the division of the first branches, the young shoots can only form around the margin of the section, and the middle part usually becomes rotten. But if cut higher up, the growth becomes symmetrical, and the trunk remains sound.

Pollards—wrong method.

Pollards—right method.

It is a good rule in forestry, never to allow the use of climbing-spurs on account of the injury that they do to the trees, and that in using a ladder, the top should always be fastened by a strap, to prevent displacement by falling branches.

METHOD OF TRIMMING RECOMMENDED BY THE COUNT DES CARS.

Some fifty years since, the Viscount de Courval applied in France a method of trimming, which he had devised, to the forests upon his own extensive domain of Pinon (Aisne), and afterward published an interesting little work upon the subject.[1] Within a few years the Count Des Cars has published a small volume, embracing the results of ample experience upon the same general principles, which he insists upon calling the method of M. de Courval. This work has gone through several editions, and has been received with much favor.[2]

Stated concisely, this method consists in suppressing "gormand" branches, and cutting off dead limbs, as well as those that grow too vertical or too low, the section being always made *close to the trunk.* He also shortens living branches, to secure symmetrical and profitable growth and to favor certain parts that should be encouraged—clears out decayed spots down to the living part, and covers all wounds with a liberal coat of *coal-tar.*

The true secret of success, according to M. Des Cars, is to *cut close to the trunk* (except where a branch is shortened at the end), never leaving a projecting part; such projection could scarcely be expected to grow over, without greatly disfiguring the tree and injuring the wood for

[1] *Taille et Conduite des Arbres forestiers et autres Arbres de grande Dimension,* ou Nouvelle Méthod de traitement des arbres à haute tige, etc., Paris, 1861.

[2] *L'Elagage des Arbres;* traité pratique de l'art de diriger les arbres forestiers et d'alignement, d'activer leur croissance et d'augmenter leur valeur. Par le comte Des Cars. Paris (7th ed.), 1870, p. 170.

M. de Courval died 1871. See *Revue des Eaux Forêts,* 1872, p. 19.

timber. Nature has provided, in a living tree, for the repair of wounds by the deposit of new wood from around the edges, which gradually closes over the injury, and, when wholly united, the annual deposit of wood goes on regularly, as if nothing had occurred to prevent it.

Effects of good trimming and of neglect.

In the pine tribe there is a tendency to the accumulation of resin in the dry branch, which prevents decay, but leads to an accumulation of wood around the dead branch, which injuries its quality for future use, and it is chiefly in this class, that the loose knots so injurious to lumber are found.

At the World's Fair in London, in 1862; at the Agricultural Exposition at Paris, in 1861; and in the Universal Exposition at Paris, 1867, numerous specimens were exhibited, showing the very best success in these operations, in the form of planks so cut as to show in the section the extent of injury and the completeness of cure; and in 1867 both MM. de Courval and Des Cars were awarded prizes.[1]

As to the question whether trimming should be practiced upon trees of all kinds, in all conditions and exposures, the author under notice appears to except only such as grow upon arid soil and in unfavorable localities, and which produce nothing but fire-wood, and says:

The coal-tar recommended should be of the thickest kind, and kept, when used, in a bucket, hung to the upper rounds of the ladder. It should be applied with a brush, and cold, except in freezing weather, when it may be gently warmed. It is claimed that it has remarkable conservative properties, not penetrating more than common paint, and yet with one coat it closes all the vessels of the exposed wood, thus effectually preventing the decay that otherwise would take place from the action of the elements. Its odor is offensive to insects, and its complete adhesion prevents them from attacking the wood. In 1863, the authorities charged with the care of the city parks of Paris, after long-continued and expensive trials of other materials, came to the conclusion that there was nothing better than this cheap and simple substance for covering wounds in trees, and have since used it by preference.

For a long period various materials have been used for covering the injured parts of trees, and from time immemorial a mixture of earth and cow-dung was thought best by those less informed, but it is needless to insist upon its insufficiency. They next had recourse to various salves used for grafting, composed of rosin, wax, and tallow, and which must be applied hot; but these, besides being expensive, would not sometimes unite with the wood, and as soon as a ring of new wood appeared around the edges, they would be lifted up more or less, leaving a naked place, which then generally became a shelter for insects. The use of coal-tar had been practiced by M. de Courval many years before it was first employed in Paris in 1863.

[1] As for the mode of payment, where forest trimming is made a regular employment in great forests, our author remarks that they should not be hired by the job, much less should they be paid out of the wood cut off. It is absolutely necessary to pay them by the day, allowing them, perhaps as a gratuity, the dead wood as an inducement for leaving none upon the tree; or, still better, to hire them by the year, paying rather more than common hand laborers, and allowing them to earn higher rates by working for farmers in haying and harvesting. He had learned to discard the professional wood-cutter; who, being accustomed to work without immediate control, is impatient under direction, and had come to prefer men that had been in the military service, and who had thereby learned habits of obedience and regularity, without having to unlearn the routine ways of wrong habits.

On wounds of moderate size, one coat is enough; but if unusually large, we should be careful to give a new coating at the end of some years, and in the extreme heat of summer it may be rendered so liquid, that it but imperfectly protects a wound to which it may be then applied. To make sure of a good result, such work might be gone over with a new coat in winter.

When this substance is applied to the elm, it is not so certain in operation as with other forest trees, such as the oak, ash, sycamore, beech, hornbeam, &c., upon which a single coat gives at once great permanence, and remains as a glistening surface. But on the elm its adhesion is not always complete, and it sometimes raises in blisters, as do paints when applied to a damp wall, and there appears an exudation of reddish, fetid juice. In such cases there is no better remedy than to return after some time, rub off the non-adhering tar, and apply a new coat. It is to be noticed that the exudation of extravasated and decomposed sap is frequently observed in the elm, without any visible cause. In such cases an opening should be made to the bottom of the diseased part, which occasions the abundant flow, and repeated applications of coal-tar will then often work a cure. A similar practice applied to oaks affected by frost-cracks will produce equally good results.

Coal-tar may likewise be used with good effect in preserving trees from the teeth of lesser rodents, as well as from sheep, goats, horses, &c., which show preference for certain kinds, such as the elm and poplar; but it should not be used indiscriminately, for, besides the danger of suffocation in a tree thus covered, we should remember that this material contains a powerful acid, which might decompose the sap. We should also use it with caution on stone-fruit trees—the plum, for example—and on nut-trees, in which the bark appears to have been sometimes altered by contact with it; but in fruits having a core, such results are not observed, and it may be employed without reserve. The author under notice comes to the following conclusions concerning coal-tar:

"From these facts we are not to infer that I proscribe the use of coal-tar upon stone-fruit trees any more than upon the elm; on the contrary, I know of no other substance which can take its place for the preservation of wood and the healing of large wounds; but when we come to treat young trees of this class, we should not daub them coarsely, so as to cover the trunk at hazard or leave it to flow carelessly down the bark, for then it will be liable to produce diseased places. The more active the remedy is, the more caution we should observe in using it."

In the trimming of the "white woods" (such as the poplars, birches, lindens, &c., so called to distinguish them from the "hard woods," such as oak, elm, beech, and ash), and in the treatment of conifers, our author remarks as follows:

"The white woods, being softer and more easy to work, are adapted to many valuable uses. Their rate of growth being three or four times greater than in the hard woods, they present special advantages for cultivation.

"The *Poplars*, thanks to their rapid growth and to the excellent quality of their wood, form a group of especial interest. The utility of trimming in their case no one will deny, and their management is precisely like that of other trees. They thrive in almost every kind of soil, but prefer the soft and moist for yielding the largest product. They therefore thrive admirably in valleys and along ditches of drainage. The soil thrown out in cleaning these ditches, if not too much at a time, gives them a remarkable tendency to sprout and send out roots from which new stems spring up, thus availing themselves of the abundance which would kill off other kinds. They sometimes grow to colossal size. The finest species that we have in France is the white poplar, and its wood has so many choice qualities, that it has received the name of "the oak of white woods." Such is their vigor of growth, that we may without trouble lengthen their trunks so as to greatly increase their industrial value, *i. e.*, we may make this part from one-half to two-thirds of the total height. The formation of their branches and the moderate strength of the wood, in fact, makes it necessary to shorten them to prevent the winds and frosts from breaking them, at a great loss.

One species, the Italian poplar, is perhaps the only tree that requires to be treated according to the old method of trimming the heads, by cutting at moderately-frequent periods all the branches except a clump at the top. The trunk, thus managed, takes an almost cylindrical form, and takes a much longer growth than when the middle and lower branches had been saved. In fact, all the branches of this poplar take a vertical direction, and consequently become almost as large as the trunk itself, which greatly adds to their value. Thus, an Italian poplar 20 meters high would have a trunk of 10 to 12 meters; but trimmed according to the above rule, it might be carried up so as to give 15 meters or more of a size proper for working. But, on the other hand, this kind of poplar will not acquire that majestic port for which it is admired unless left to itself till grown to its full size.

"The *resinous or coniferous trees* generally grow in masses, forming beautiful forests, as in the case of pines and firs, and afford a most precious resource for reboisement,[1] as

[1] The use of this word from the French (signifying "replanting with trees") has been sanctioned by use of English writers, and it will be adopted in this report without further explanation.

well for the facility with which they grow from seeding upon the spot as on account of their action upon the soil in preparing it to receive other kinds, and especially the oak. Of the two forms of trimming (cutting close to the trunk, and shortening the branches), the second is not generally needed in the firs, because their growth is naturally upright and pyramidal. It is, therefore, in most cases only necessary to remove the dead or dying branches. But it is not so with the pines, which will, when not closely planted, often form enormous branches, to the injury of height and beauty in the trunk and to a great loss in their value. With them, the shortening of such branches is absolutely necessary, as we have described in the case of deciduous kinds. This should be done by taking off a third or a half of their length, but always beyond the secondary branches. This requirement is more rigorous than in deciduous trees, because such a stub, deprived of its branches for support, would unavoidably perish. By this means we may recall the tree to that form which it should take in normal conditions, and the main trunk will elongate and grow large in regular form and to greater profit. Every one knows the importance of resinous timber in civil and naval architecture, and especially its use for masts. In proportion as the tree grows old, its lower branches die and dry up, but the resin with which they are filled prevents them from rotting. The dead part, however, remains enveloped in the newer wood in the form of knots, which interrupt the longitudinal fibers and injure alike the growth of the tree and its use for the carpenter, forming holes in the boards or plank when they are wrought for use. These faults are easily avoided by cutting all dead or dying branches close to the trunk; and a coat of coal-tar is of use in preventing, or at least considerably reducing, the flow of resin.

The mode of trimming which leaves pegs in the place of branches is objectionable in deciduous trees, and still more so with the conifers, for they must always in a few years be in turn cut off. Some persons have adopted this method to avoid the loss of sap, but, in every case, if left, they ought to be cut off smooth the next year. This greatly increases the labor, and it cannot therefore be practiced on an extensive scale. If the stubs are left they will form burrows in the new wood, or, if left some years, they will occasion defects in the growth two or three times more in diameter than if cut off smooth at first.

The practice of trimming the pine is very common in France, but it is generally overdone, the head left being insufficient for growth in size. If the branches are well formed, the trimming ought not to be carried to over a half, or, at most, two-thirds of the height, while young trees should be allowed to retain relatively more branches than those that are older.

The method of trimming advocated by M. des Cars has been to some extent tried at the French experimental station at Barres and elsewhere. When properly and intelligently performed it yields unquestionably good results, but it requires good judgment, and is in fact a kind of skilled labor, which costs more than common hand-work, and the question of expense may prevent its general introduction in the management of large forests, even in European countries, where wood is dear and labor cheap.

While speaking of the process of pruning or trimming forest trees, it may be proper to remark, that zealous advocates of particular methods have heretofore done great injury by advising the operation as a general rule, without paying sufficient regard to the particular conditions of each case. Some forty years since, Mr. Gavin Cree introduced in Scotland a method of pruning, founded upon an erroneous theory of the functions of the leaves and of the sap, which led to the shortening of all the branches, from the bottom of the tree to the top. It is hardly necessary to add that time has proved not only the fallacy of this doctrine, but has also shown the irreparable injury that followed its application. At a still earlier period, a method of pruning was introduced in England by Mr. Wm. Pontey,[1] nurseryman to the Duke of Bedford, which cannot now but be regarded as having done a great deal more of harm than of good, because practiced without discretion and an undue extent.

These results have led some writers to take the other extreme by

[1] This system is set forth in a work entitled "*The Forest Pruner, or Timber Owner's Assistant*, &c., London, 1805.

advising to let nature have her own way in suppressing the branches that are no longer useful.

The system of pruning proposed by M. des Cars has been opposed and defended with much earnestness, and many arguments for and against have been presented. The following observations presented to the Central Society of Agriculture of France, by M. Delimoges, enumerates some of these arguments, while it strongly defends the practice:

The system of pruning close to the trunk, has had the lot of all useful discoveries' that of being keenly criticised, especially at first. We should not complain of this, because these strictures have served to call the attention of foresters to it, and have led to some experiments everywhere. Now, thanks to these experiments, some of which are now old, experience brings daily new favor to the method, and answers to the objections become every day easier. It is scarcely necessary to recall all of them, as those who experimented upon the method have been convinced, and have yielded to the logical sequence, including myself, before I began to practice it on an extensive scale. They said to me: "Have you counted on what you are about to do?" "Don't you know that a tree lives by its *leaves* as well as its *roots*, and that they are necessary for its growth, which is proportioned to their number and surface, quite as much as to the activity of absorption by the roots?" "Will you oppose nature and pretend to do better?" "You will ruin your trees!" "And then, why cut close? You will waste the sap, create decayed holes, and in ten years your trees will be rotten; you will have lost your forest, and *the wood-merchants will not buy of you.*" The fatal word was said—a phrase that was to end all further discussion.

This fearful presage did not stop me, and in 1862 I began to apply trimming on a high forest of thirty hectares, and the next year fifty-four, and have since continued without interruption, except when hindered by the German invasion of 1870–'71. I have now about six hundred hectares submitted to the mode of trimming prescribed by des Cars, and I ought to be allowed to speak of the result. The numerous and persistent observations I have made have led to the conviction that most of the vicious knots from caries and decay that have been found upon trees thus treated may be ascribed to a neglect, rather than to an observance, of the rules which have been prescribed.

It happens thus: The workman has before him an oak with dead branches—some of them long dead—perhaps the stub of an old trimming, which, decaying itself, has carried rottenness into the heart of the tree. He cuts it off, and, if not intelligent, he pays little attention to its condition, and, without stopping to clear out the rotten part, he will, unless watched, paint coal-tar over the spot and call it done. By and by the tree is cut down, and a great rotten place is found at the knot and within the tree. There is at once a great stir in the enemy's camp—*a tree has been ruined by close trimming!* Is this just? I have made some careful experiments at closing such holes, and in a few years have succeeded in closing them by paring the edges and starting new growth. * * * The amputation of a branch done under normal conditions should cause neither decay nor bleeding. Since 1862 I have carefully observed the effect of this operation, and wish to give my report. I began by offering the guards a reward of 0.25 francs for every diseased wound from trimming which they could find, but they found none. I then raised the bounty to stimulate their zeal, one franc at a time, to 5 francs, but up to this day I have not had occasion to pay once.

I should, however, explain by saying, that whenever the workmen employed in trimming found a vicious knot-hole, beginning to decay, they brought it to the notice of the foreman; they let it alone, he examined it and informed me—it was visited, and if really bad, and in no condition to remedy, the tree was cut down at once, as not likely to be ever better. I will add that, having often need of timber about the farms, I have, by preference, cut down such trees as had been wounded and healed, so that I could study their sections. I have not found the trace of rottenness. These specimens I have saved, and shown at exhibitions, the concentric layers covering the section and only a thin black line to be seen, caused by the coal-tar, but not a trace of decay.

There is still another thing to which the workmen should give greater attention. It often happens that when the tar is applied the cold hardens it, so that it scarcely adheres, and the brush *draws*, as they say. The pot should then be warmed till the tar is liquefied, but not too thin, for then the coating would not be thick enough to shield the wound against the sun, and little cracks would appear, admitting water and insects, and a wound badly covered would afford a strong argument to the enemies of this method. This observation has with me very great importance. Very often the workmen will do as here explained, and I am well assured that there are those who, meeting with a defective cutting close to the trunk, would at once ascribe it to the fault of the method, rather than the neglect of the workman.

It is pretended that by close cutting the branches we reduce the surface of leaves, and injure the growth of the tree for at least a year, because it needs the materials for

reserve, &c. There is nothing less proved than this assertion, and I will add less probable, notwithstanding the statement of Pressler. As all the old trees in the forests of Bagny and de Clux bear a number painted upon them, nothing is easier than to ascertain the exact rate of growth since their trimming. From various reasons, such as want of time, &c., some small parts of certain cuttings have been left without trimming, so that excellent means for comparison are at hand, and which I have used, leading to the conclusion that the absorption above mentioned is not shown. If anything, I believe the contrary to be true; at least this is my own observation.

They say that a tree thus trimmed dies, after a few years, from the loss of leaves—the principal respiratory organs necessary for its life; but this is a double error. First. It is by no means proved that the absorbent surface is sensibly diminished by trimming, which suppresses some of the lower branches, but produces a considerable growth in the top of the tree; so much so that when winter comes and the tree is bare, in a good trimming we are surprised to see the tops of all the oaks present a silvery color, indicating a new and vigorous growth. It is here we see the effect of trimming, as it is easy to show, and as I have often pointed out to persons who have visited me, and sometimes to stop their criticism. It was in fact a part of the problem to be solved, to raise the high forest, and at the same time the coppice, so as to let in the air and the light. To pretend that a tree dies when once its reserve is lost, seems to me still more difficult to maintain. I have here, and offer to show the proof, that nothing is more contrary to truth. I have some trees trimmed twelve or thirteen years ago, and I challenge any one to show others more healthy or vigorous. I will go farther, and say that the trees not trimmed are less vigorous than those that have been. I claim, in fact, that not only does the trimmed tree not perish, but that, on the contrary, it revives under the operation judiciously done; that it takes new vigor, its center of activity, instead of being wasted in nourishing large useless branches, being thrown into the top, to the great benefit of the owner.

I have time and again used the word *judicious* as applied to trimming, for excess is injurious, and abuse may lead to bad results. We should evidently cut from the tree no branches but such as may be shortened without inconvenience or injury to proportion. Surely, when asked to make an old tree that has lost its vigor and has not long to live a new one, by large and repeated wounds, the forester would pause and reflect whether there was much chance of success. He would weigh the reasons for and against; and this is an affair of the judgment. And furthermore, I wish it well understood that in speaking of trimming, I do not refer to aged trees, but to young and growing trees. With the former, the results do not admit of discussion, and it is vain to seek arguments to defend them. I again repeat, and cannot too often, that the operation is a delicate one, and ought not to be trusted to the first comer.

It requires conscientious and intelligent men who have made themselves masters of the subject. It is better not to trim at all than to trust the work to unskillful or careless persons. The work, if done, should be well done, and it will be fertile in good results, but otherwise it will end only in mischief. For this reason it is desirable that the school of instruction which the Count des Cars has opened on his estate at Rozet-Saint-Albin should be continued, as the true means of forming careful operators, who in turn may instruct others, and thus advance the use of good methods in trimming.[1]

I now come to the grand objection, "*The wood-merchants will not buy of you.*" This point is so important that it should be answered by facts as definitely as possible, and I would beg leave to cite my own personal observations. All the oaks in our forests, which of right enjoy a good reputation, are squared and worked in the yards upon the premises—none going away in the log. I have thus been able to follow the work done upon many pieces treated by this method, ten, twelve, and fourteen years ago, and I have never seen any serious inconvenience in my own case; and as for the merchants, *they have bought the timber*, all I had to sell, without objections, and at a very good price. I have just sold three lots of wood, amounting to 141,360 francs, from 75.36 hectares; that is to say, at an average of 1,880 francs to the hectare (about $152 per acre). The lots were 22, 18, and 17 years old respectively, and coppice under large timber. It is not there that they have abused me by running down the price of my wood. No, this terrible objection is no more serious than the rest. The merchants must be supplied, and it is their business to buy to the best advantage, and this has not kept them from taking what suited them, and at a good price, whether trimmed or not. To come to the bottom, and I speak of those who have worked this timber, they know well enough thas this objection amounts to nothing. * * * For a long time I had no imitators. I have now, and among them those who have been the strongest opponents—the kinder class calling it my *innovation*, and the others my *folly*. The foresters of the State service

---

[1] M. des Cars in 1875, and again in 1876 and 1877, gave practical courses of instruction upon his method of pruning. They lasted about ten days at a time, the expense being 25 francs to pay for board. Three courses were given in the spring. The director-general of forests decided in 1877 to send a number of the candidates for state forest service to learn the process as illustrated by this zealous advocate of trimming.

have adopted it, and I have seen with surprise and pleasure their workmen trimming close to the trunk in the State forest of Pourlans, adjacent to my trimmings of Clux. In the Cote-d'Or the forest administration imposes on contractors for cutting wood to supply the communes, the duty of trimming close, and I have many times lent them tools and coal-tar for this use. I will add that the administration appears to me (and properly) convinced of the importance of a very rigid supervision, as it has decided that *trimming out of sight of a guard shall be deemed a trespass.* This is an excellent measure, as it throws the responsibility upon the guard, and compels in him an active surveillance. I am far from affirming that this practice has become general throughout the Cote-d'Or, but it is in force in the communal woods adjoining the forest of Bagny. The administration of *Ponts et chaussées* has used since 1869 the practice of close trimming upon trees planted along certain departmental roads, by practicing the method of M. des Cars and covering the wounds with coal-tar, and they are to be complimented for the fine result of these plantations.

The conclusion that I draw from the above is, that the objections brought against the method are not well founded. They apply only to the exceptions, to operations badly or unskillfully done, and, reasoning from probabilities based upon these inductions, they build a fragile scaffolding of suppositions more or less judicious, but without asserting any statement which the experience of actual results does not prove to be false.

The system of trimming of the Count des Cars, which its opponents themselves admit to be logical, has no need of defenders; it will defend itself by its own results. But it is needful that these acquired results should be made known, and this duty is incumbent upon those who first entered upon the career, and it is to this end that I have brought together these observations that I now submit.

THINNING OF PLANTATIONS.

In a young growth of natural seedlings, the plants are often densely crowded; but as they become larger the feeble ones die, and others lose their lower branches; and so, from year to year, the numbers diminish in the struggle for life, until but a small part of the first number comes to full maturity. The careful forester seeks to imitate this process of nature, by securing a sufficient growth for shading the ground from an early period, and by reducing the numbers as the trees increase in size. These labors include the clearing out of the worthless bushes and brambles that never come to useful size, but is chiefly secured by giving the greatest opportunity possible to the most valuable kinds. No rules can be given for the execution of this work, without knowing the conditions, further than the general statement, that it should be done where-ever required, and as often as may be necessary.

With respect to the removal of a part of the trees of the valuable kinds, where crowded, great prudence is to be exercised, because the whole growth, if standing dense, if too much exposed at once, would be liable to suffer from the winds, or from the weight of snows. The precept laid down by Lorentz and Parade for the first thinning is as follows:[1]

The principal rule to be observed in a thinning of this kind is to keep the trees conveniently close, and, in a wrod, *never interrupt the continuity.* In a young wood, which has hitherto grown very dense, the stems are very thin and slender, and have the greatest need of support. An imprudent clearing would expose them to storms; they would be injured by the weight of snow and ice, or even bent down by the weight of their own tops. In such a growth, it is to some extent necessary to save some of the poorer kind as protectors, and allow them to stand till the next thinning. We should also remember that the young trees must obtain the greatest height possible, and this can only be done by keeping them close. At an older stage of growth, the inconvenience of too much thinning would be less injurious. Moreover, if opened too much, the grass and weeds will get in and absorb a part of the aliment of the soil; or, if it be a seed year, a new crop of tree seedlings will cover the ground, which is to be, if possible, avoided.

The age at which the first thinning is needed cannot be fixed by any rule, as it depends upon the rate of growth and the various influences to which it is exposed. It should begin as soon as the lower branches begin to die and drop off, and should be repeated more thoroughly when the trees get to be three or four inches in diameter at

---

[1] *Culture des Bois,* 2d ed., p. 174.

the ground, and afterward from time to time as may be necessary till the forest gains its full maturity. These operations may be repeated every five years at first, and afterward at longer intervals. In the State forests of France, where the most valuable timber is the object, and time of less consequence, the interval is some fifteen or twenty years. Although in these operations no particular number of trees can be fixed as a rule, it may serve as some guide to give the following as approximately the proper number to be left:

At 30 to 40 years—1,300 to 1,620 to the acre.[1]
At 50 to 60 years—490 to 608 to the acre.
At 70 to 80 years—305 to 410 to the acre.
At 90 to 100 years—200 to 360 to the acre.

The selection of trees to be removed in thinning out forests so as to allow the reserves the better chance for development, can best be done in summer, when the foliage is the densest, and the effect of shade the most apparent. An experienced eye can at such a time more readily judge as to what trees are most promising and what can best be taken out.

A recent writer upon practical forestry[2] in speaking of the proper time for thinning a plantation, recommends that it be done early, and assigns as a reason that the remaining trees will then have seasonable opportunity for developing their lower-side branches. He remarks:

It is those branches situated upon the lower part of the stem of the tree that supply food and nourishment to the roots, and unless they are preserved vital at this critical period of the tree's existence it very soon ceases to develop itself and make wood. In fact it ceases to grow to anything like satisfaction at that very early period when it should be making wood faster than any other. To the preservation of the lower branches of the celebrated larch forests of the Duke of Athol, more than anything else, may be attributed their successful growth. The larch there were planted 6 feet apart, and that distance, admitting that all the trees grew, allowed all the lower branches to grow 3 feet in length all around. But as many of them would no doubt decay, and from accident and other causes perish, many of the trees would thereby produce their lower branches twice that length, hence the unparalleled results of the growth of the larch in these forests.

Having witnessed so much injury inflicted upon young plantations and some entirely ruined by the lower branches being interfered with at a stage of growth too early, I would recommend in the strongest possible terms the special attention of all who have the management of plantations to this particular aspect of the subject. It is often asked what rule can be given and how it may be known when either individual trees or plantations have the exact and proper quantity of branches upon them. The rule for this is, as far as any rule can be given, to maintain a due proportion of girth to the height of the tree, and these proportions are girth in inches to feet in height. For example, a tree twelve feet high should have a girth a little above the swell of the root of twelve inches, and so of larger sizes. When trees attain the height of 30 or 35 feet thinning should be entirely discontinued, and frequently it should not be prolonged after the trees are 20 to 25 feet in height, but allow the plantation to grow undisturbed (except by cutting down dead or decaying trees) till it is ripe for cutting down and clearing the ground. There is a danger of old trees having too many as well as too few branches; but there is no danger of *young trees* having too many, and if the rule given should be observed there will be no superfluity of branches at any time, for if the proportional girth is too great it can soon (if there are sufficient trees upon the ground) be reduced.

The form of the tree, up to the period when the thinning should be discontinued, should be conical or tapering, both in the stem and general form of the tree. After thinning is discontinued the shape of the tree alters, both in the stem and branches; the latter wither and fall off, till only the top is covered, and the form gradually changes from a cone to a cylinder. The cause of this is the increase of woody deposits near the live branches, and the decrease of it where the branches have fallen off.

---

[1] In France, Duhamel and Varenne de Fenille advised a much greater reduction, allowing, in fact, almost as much land for an oak as an apple-tree in an orchard. The object in view was the thickness of the trees, rather than the height, and such broad spreading trunks as ten or eleven meters between the trees would produce, could not fail of yielding an abundance of the crooked pieces so much prized in ship-building.

[2] "On Thinning Plantations, as applicable in Practical Forestry," by Christopher Young Michie, of Cullen House, Cullen. (*Transac. of Highland and Ag. Soc.*, 1876, p. 199.)

This writer points out various reasons that should prevent late thinning of evergreen plantations, among which are the insufficiency of roots in trees closely planted, and which are not able to support them when exposed to the winds, the injury that the sun may cause upon the trunks and branches that have been accustomed to the shade, and the effect upon the roots when the ground is too much exposed; although all of these parts may in time become accustomed to these different conditions. He regards the thinning of such forests a delicate and dangerous operation, except when practiced while young, and mentions some forests in splendid condition, which had scarcely been trimmed at all. In one the trees stood 9 feet apart on an average, some as far as 15 feet, and others as close as 2 feet. The market-value of such a forest, if the trees were all sound, would be at least £300 per acre. The ground was a light, sandy gravel and very poor. He advises that all thinning should be begun before the side branches touch each other, and that it be continued till they are 8 feet apart, after which he would leave them to nature to complete their growth.

As to the larch, our author remarks, "It gains the most by thinning and suffers least from it. It is very impatient of confinement, and enjoys freedom although it comes late. On the bare, pole-like trees that are left, lateral branches will form beyond anything witnessed in other forest-trees. Unless the trees are sound and healthy, however, no lateral growth will take place by thinning." He mentions some stumps of this tree that had remained alive more than twenty years after cutting, without being able to account for the phenomenon. He regards the two greatest errors of foresters as "being too late in commencing to thin, and continuing the operation too long. It does much good if done early, and equally much harm if done late."

ON THE CULTIVATION AND MANAGEMENT OF COPPICES.

The *coppice* is a growth of timber of various deciduous kinds, from the stumps of a former growth, and is usually cut before maturity, at intervals of from ten to forty years, according to circumstances and the uses to which the product is to be applied. This mode of cultivation is in great favor for the growth of fire-wood, and the smaller woods used in various industries, and is the means by which tanning materials are often produced from the oak, where reliance is necessarily had upon this means for supplies. The coppice of short periods produces hoop-poles, and the stakes and vine-props so much used in vine-growing countries, and in many parts of this country may be able to supply, with but little care beyond protection, the fencing material and other woods required for farm purposes. It is destined to be in future of great importance in the growing of poplars for paper-making.

The trees that sprout best from the stock are the ashes, elms, oaks, poplars, cottonwoods, willows, chestnut, linden, mountain ash, maples, sycamore, birches, alders, and hazel. The beech will reproduce but slightly, except in very favorable conditions, and the conifers not at all, with the single exception of the California redwood. Whatever may be the effect upon the durability of the timber by cutting at particular seasons, we have in case of coppice growth no alternative choice, and must cut in winter, and by preference toward the approach of warm weather, but before the sap starts, as at this time alone will the stumps be in best condition for sending up a vigorous crop of young shoots. The months of February, March, and first part of April are generally best for this labor.

In cutting, with the view of reproduction, the stumps should be left low, and the tops sloping and smooth, so as not to admit water. It is sometimes the practice to dress off the stump in a convex form with an adze, taking especial care not to separate the bark from the trunk. It is along this line of union between the wood and the bark, that the young shoots start, and if separated, they will not sprout.

In precipitous glens and waste places difficult of access, it may often be found more profitable to cultivate wood as coppice rather than to allow it to grow to full dimensions, partly because wood of small size may be got out of such places where timber of large dimensions could not be removed without its costing more than it was worth, and partly because the relatively rapid growth of wood in its earlier years may in the end yield more material than if allowed full growth. Thus, for example, two crops of twenty years each may be worth more money than one of forty years, and in like manner for older growths, although for certain purposes the latter may be adapted to uses for which the former would not.

There are also cases in which an impervious or barren subsoil may arrest a growth of timber when it comes to an age where its roots should draw their support from it. Here there appears no alternative to cutting at a comparatively early period. Such cases occur also where the soil is underlaid by rock near the surface, and in which, from liability to drought from this cause, it may at times be more profitably left for trees than for pasturage or other farming uses.

In the cutting of coppice woods, it is often the practice to leave a certain number of choice trees of the more valuable kinds to grow to full maturity, and thus acquire a much greater relative value than if cut small. These reserves may be kept through two or three periods or "revolutions." They influence the young growth, by their cover and shade,[1] and when properly distributed may be, on the whole, beneficial rather than injurious to the future crop. They should not cover more than a twentieth, or at most a sixteenth, part of the whole surface. As the same stocks will be weakened by repeated cutting, care should be taken to secure new roots from time to time, and one means of doing this is to bend down the tops of some of the sprouts and bury them partly in the soil, by which means new roots will in some species form, and, when fairly established, they may be separated from the stock. Such sprouts should be held down by hooked stakes, and the tops kept in position by a piece of sod.

In the coppice forests of Morvan, which supply about one-third of the fire-wood used in Paris, the cutting begins after the fall of the leaf and as soon as the movement of the sap ceases—that is, from toward the end of October or first days of November—and continues till about the middle of April, when the sap begins to return in spring. If continued later, it would injure reproduction from the stools. The cutting is, however, rigorously forbidden during severe frosts, on account of the damage that might happen at that time from the separation of the bark on the stools from the wood. As the new shoots spring from the line of junction of the wood and bark, this accident would render reproduction impossible.

---

[1] Lorentz and Parade draw this distinction between *cover* and *shade:* The former includes the space actually sheltered by the top and branches; is a constant quantity, except as it enlarges by growth, and is injurious to the growth under it, by weakening the effect of the light and the rain and by preventing dews. Shade is the interception of sunlight, and may extend far beyond the tree. It may be highly beneficial to the growth of young wood by keeping the plants cool and damp, without excluding them from the free action of the air.—*Culture des Bois,* 2d ed., p. 265.

The forests of Morvan consist of about one-half beech, one-fifth oak, one-fifth hornbeam, and the remainder of "white woods."[1] Particular care is taken at each cutting, to leave the stool a little shorter than it was before, so as to take all of the new wood. This is especially important with the beech, which, under this treatment, will give a fine vigorous growth through two or three periods of revolution. Its highest vigor of reproduction by shoots is at about twenty-five or thirty years of age; but when the stumps become large, they are apt to become hollow and the vital power feeble.

It is always desirable to have the young trees secure some independent roots, as may happen when the cutting is done close to the ground.

A Scotch writer remarks that the oak coppice after growing two seasons should have the shoots around the edge of the crown or stump thinned, leaving six or eight on each, preference being given to those growing from near the ground, and that will send down some roots of their own.

The second thinning may be done in about six years, and the shoots reduced to two or three to a stump. The shoots cut at these thinnings are sold in bundles of 100, trimmed to the point, for crates and hampers, and those of the beech for brooms.

A third thinning and trimming is had two years before final cutting, the vigorous growth thus given tending largely to increase the amount of tannin in the bark, while trees in this condition peel more easily.

When a stock has become decayed, or from careless cutting so high that shoots cannot spring up to advantage, it should be cut down level with the ground, when the roots will send up new and vigorous shoots, which will get rooted on their own account.

When oaks are planted in Scotland for coppice, they are generally set 8 feet apart and the intervening spaces filled up to 3 feet apart with larches. The latter should be progressively removed during the first 15 years' growth, and the oaks encouraged to grow in a stout branchy habit, so that they will at 20 years have stumps 6 or 8 inches through When properly managed, the sale of crate-wood and other thinnings will in that country pay all expenses of management.

"SARTAGE."—In some European countries, upon cutting off a growth of coppice timber, the brush are strown evenly over the ground or piled on the old stumps too large to send up shoots with profit, and the whole field is burned over with fire; a sufficient guard being stationed to prevent the fires from spreading. The ashes are found to fertilize the ground and the heat is not enough to injure the roots. A crop or two is cultivated, usually buckwheat or rye, which must be reaped by hand, so as not to injure the young shoots which presently spring up and shade out everything but themselves. This process, which the French call *sartage* (wrecking), is chiefly followed in the Ardennes, and near Liege, Luxemborg, and the south of Germany, and succeeds best with oak coppice, cut off every 20 years for tan-bark and fire-wood. It is there followed by a greater aggregate of wood-growth in a given period. It cannot be practiced in all places, being best where the soil is a deep, strong clay, that is liable to retain much moisture. It is sometimes done by "covered fire;" that is, the soil is peeled with a hoe, including the herbage, sod, and mosses, which are piled and burned, and their ashes scattered over the soil. These fires will smolder many days, and, of course, fill the air far and near with a noisome odor.

[1] This term is applied to willows, poplars, alders, and lindens, to distinguish them from hard woods.

These smoldering fires are condemned by the best writers, because they consume much of the humus and impoverish the soil a great deal more than the ashes improve it. The running fires burn quickly, do not injure the stumps from budding, and improve the vigor of growth when the sprouts start. They give a crop or two of grain, and when judiciously managed, are a decided advantage where circumstances favor.

FENCES.

In no branch of rural economy is there so much needless waste of forest products as in fencing, and in nothing is there so much need of reform. The costly practice of fencing cattle *out* of fields where not wanted, instead of *in* fields where they should be kept, would become apparent by a simple calculation, and the economy of inclosing large fields instead of small ones may be easily shown. A single square acre requires 50.6 rods of fence to inclose. The amounts required for a mile square and various subdivisions are shown in the following table, in which the calculation is made for separate inclosures—and for the entire mile square, the same subdivision fences in the latter case answering for two adjacent fields.

Rods of fencing in squares on one square mile.

Number of fields.	Area of each field.		Fields adjacent; one fence around the whole mile square.		Separate fences around each lot.		Saved on a square mile by having fields adjacent.	
	Acres.	Square rods.	Rods of fencing.	Rods of fence per acre.	Rods of fencing.	Rods of fence per acre.	Rods of fencing.	Rods of fence per acre.
1	640	102,400	1,280	2	1,280	2	0	0
4	160	25,600	1,920	3	2,560	4	640	1
16	40	6,400	3,200	5	5,120	8	1,920	3
64	10	1,600	5,760	9	10,240	16	4,480	7

It has been stated, by those who have examined the subject, that from one-quarter to one-eighth of the present fences of the country would be amply sufficient to keep stock within proper limits. The amount thus saved in a year would amount to millions of dollars in some of the larger States.

Estimates have been made showing the cost of fences in the United States to be $1,700,000,000, and the annual cost for maintenance at $198,000,000, including interest at 6 per cent. upon the original cost. Instructive papers on this subject were read before the Connecticut Board of Agriculture in 1875, by T. M. Hubbard, and by Donald G. Mitchell, which are published in the report of the Board for that year, pp. 15-30 and 171-190, with the discussions that they raised.

At a meeting of the Maine Board of Agriculture in February, 1876, the subject of fences was made a special topic for discussion, and many interesting facts presented, the general tendency of which was, that the cost of their maintenance was vastly beyond the actual wants of the country. Two separate estimates gave the amount of farm fences in the State as 40,644,800 and 41,952,000 rods, or from 127,000 to 131,000 miles. Their first cost could not be reckoned at less than $1 a rod, and the interest on this sum, with repairs, snow-bills from drifting, &c., was estimated at about $6,000,000 per annum. This did not include the use of land which, reckoned at 8 feet in width and $30 an acre, would amount to $975,990.

Already in some sections of the country, a fence around the wood-lot on a farm is deemed quite as important as around the pasture; in fact, the free range of cattle may be considered as *absolutely inconsistent with*

the growth of young timber, and the sooner this is learned by the farmer, the better it will be for the woodlands of the future. This cannot be urged too strongly, or observed too strictly. Aside from the eating down of young shoots, the consolidation from tramping tends to injure the young trees and hasten their decay. The damage done by sheep and goats is greater than from horned cattle and horses, and in Europe is one of the first causes of the injuries that have happened in mountainous regions from the erosion of torrents. The range of swine is least injurious, and is permitted in well-kept forests after the timber has reached a certain stage of growth, and at proper seasons of the year.[1]

HEDGES.

Hedges may often serve every purpose of fences, with the additional advantages of affording wind-breaks and nesting-places for insectivorous birds, and sometimes by their products of fuel or other material from their growth. This is more particularly true of the willow, when allowed to grow to a large size, and the Osage orange, where the soil and climate favor the growth of a tree to full size, at intervals along the hedge. Our limits will not allow us to enter upon details of their planting and management. It should be remembered that they have their disadvantages as well as benefits, among which may be mentioned the following:

1. Permanence sometimes not desirable, and in wooden fences more easily managed.
2. Expense of maintenance, including use of land and labor of keeping in order. In such as send up shoots from the roots they may become aggressive.
3. The harboring of noxious weeds and accumulation of dry materials, the former requiring much care to eradicate, and the latter being dangerous in case of fires.
4. The dampness caused by their shade may keep an adjacent road muddy.

It would be difficult to decide before trial as to the plants best suited for a hedge in a given region. We have found the English hawthorn well adapted to some localities, but it is not hardy or desirable in the Western prairies. Our native thorns have proved suitable in some cases.

The OSAGE ORANGE (*Maclura aurantiaca*) has been widely planted throughout the Western States, but often beyond the boundaries of profitable growth, and undeserved complaints have been made on this account. In many parts of Iowa it appeared to thrive well for a few years, but is now dying out. Wherever the shoots are killed back by the frost every year, or every few years, it will hardly long succeed;

[1] It was forcibly remarked by Sir John Sinclair, in his *Code of Agriculture* (5th ed., 1832, p. 471), that "a landlord had better admit his cattle into his wheat-field than among his underwood. In the one case they only injure the crop of one year, whereas in the other, by biting and mangling one year's shoot, mischief is done to the amount of at least three years' growth." In fact, if the injury is allowed to continue, and the amount of stock is considerable, there will generally be found no young shoots and but little foliage within their reach that is not destroyed, and reproduction from seed or stools is altogether out of the question. In some European countries, rights of pasturage by the common people have proved the greatest of burdens until these rights were extinguished. In the United States, where the tenure of land is generally absolute, the subject is simplified down to the point of excluding the range of herbivorous animals, until the foliage is above their reach; or, if the underwood is to be preserved for the reproduction of timber, their permanent exclusion.

but in regions where it is not liable to this accident it is unquestionably the best hedge-plant we have.

The HONEY-LOCUST (*Gleditschia triacanthos*) has been strongly recommended as a hedge-plant in Iowa, where the Osage orange is found uncertain. Its thorns are effectual defense against farm-stock, and when cut back and trained in broad-based pyramidal form it soon takes on a dwarfed habit, and when once fully established, is said to require but little care. It has been found to do well on high grounds as well as low, and has passed through severe winters unharmed.

The SCARLET THORN (*Cratægus coccinea*) is hardy, and forms an effectual hedge. It is a native of cold regions, and would thrive in any of the Northern States where the soil was favorable and the climate not too dry.

The HEMLOCK (*Abies Canadensis*), when closely planted on stiff, moist soils, and carefully trimmed, forms an excellent hedge in those sections of the country where the climate favors the growth of this tree. The best time for transplanting is after the buds have broken for a new growth, or just as the plant is about to put forth its energies for the season.

The AMERICAN ARBOR-VITÆ (*Thuja occidentalis*), RED CEDAR (*Juniperus Virginiana*), and other conifers in great variety, have been found admirably adapted to hedge-planting, for ornament and use, and many of these are elsewhere more fully mentioned in this report.

WILLOW HEDGES.—In Northern Iowa, where the Osage orange is too tender for the climate, the white willow has been found to answer an excellent purpose as well for a hedge to stop cattle as for a wind-break. Mr. Thomas Wardall, of Mitchell County, gives the following advice in the cultivation of this tree :[1]

> Let every Northern farmer plant out a willow grove with good large cuttings in early spring. Plant four feet apart both ways, and cultivate well for two or three years, and a large growth will be secured. When five years old, trim out all but one plant to each hill, cut off stakes five and one-half feet long from these trimmings, sharpen these stakes and drive them eighteen inches deep in a well-prepared fence-row. When the soil is soft in the spring the driving can be done without bruising the bark. Let the stakes be driven closely—not more than six inches apart; nail a stay-lath near the top—a three-inch barn-batten answers the purpose well. Mulch heavily, or cultivate well and often. In two years a fence may be made that may be depended on to turn stock, but which will have the one fault of not being beautiful.

The willow as cultivated by Mr. W. would not bear plashing or even weaving, but the tops afforded a constant supply of indifferent fuel.

Col. John Scott, of Story County, in Central Iowa, reported in 1876[2] that many miles of willow hedge were planted in that county, and that more than one hundred miles would be found a complete barrier against stock. Many miles had been set in a random, aimless way, and were worthless as a fence, although somewhat profitable as fuel and shelter.

He gives his method for successful planting as follows :

> 1. The row should be made mellow and deep, and the better the condition as to richness, freedom from weeds, and good tilth the better. If in good condition for corn, it will do for the willow.
>
> 2. The cuttings should be made before the buds swell in the spring; they should be packed in moist earth to keep them from drying out; they should be from the upright, rather than the lateral growth, as being more thrifty; and may be from six inches to six feet in length, and from one-half to four inches in diameter.
>
> 3. It is best that they be assorted before planting, so that those of about the same size may be planted together.
>
> 4. They should be set in a straight line and only one row planted, and should be ten or twelve inches apart. The cuttings are often set too closely. They should have room

---

[1] *Report of Iowa Horticultural Society*, 1875, p. 148.
[2] *Ib.*, 1876, p. 148.

to grow and gain strength and stiffness, as it is in this way that they make a barrier, and not with closeness and thorns, as is the case with some other plants. I have seen trees that were set five or six inches apart in the row, and in rows four feet apart, intended for shelter from winds, many of the trees not being more than two or three inches in diameter after a lapse of eight years, while other cuttings planted at the same time, with plenty of room, are more than a foot in diameter.

5. The planting should be as early as the ground can be got in good order. I have never planted in the fall, but, reasoning from analogy, I see no reason why they might not be planted then as well as other cuttings, if protected.

6. If the cuttings are one or more inches in diameter, and three or four feet in length, which is better than if larger, they may be firmly set twelve or fifteen inches in depth. The setting may be done with a crowbar, by ditching or by driving. Short cuttings may be set so that the top is lightly covered with fine soil, which prevents their drying out, and confines the growth to a single bud.

How to cultivate.—No other crop will pay better for good care. A proper degree of moisture should be maintained, as of the utmost importance. Frequent stirring of the soil is of great benefit in this respect, and also tends to keep out weeds and other growth that sap their moisture. Mulching for three or four feet on each side of the row seems to perform these offices quite well, and when well done saves all other labor, and is for that reason the safest course in the hands of a careless or too busy man. I have seen cuttings planted on the same day, and with the same soil and treatment in all respects, except that part were mulched and part were not, and where the former succeeded well, the latter utterly failed. I have seen the cuttings when not mulched, make a nice start, but perish in the heat and drought of summer. I have seen large cuttings, driven into an unbroken prairie-sod, make a fine growth when a sufficient mulch was applied to subdue the native grass. But in this manner of planting, the mulch should be heavy, and should extend at least five or six feet on each side of the rows to give the plants a fair chance. It would be better, within a year or two thereafter, also to break a greater width outside of the mulch, as the sod would interfere with the growth of the trees, as soon as the roots should reach that distance. Straw, hay, stalks, manure, saw-dust, anything that will mechanically serve the purpose of mulch, will answer, but manure would stimulate the growth very satisfactorily. * * *

Cutting back may be resorted to in cases where there has been a poor stand, but not where the plants stand within twelve or fifteen feet of each other. The trees should not be plashed down or woven together, but should be stimulated to make a strong, upright growth. Late planting is even worse than close planting. This is especially true if the buds have started before the cuttings were made, or if they have been allowed to dry before setting. While young and tender, the shoots must be guarded from live stock. Calves will eat the tender shoots, and keep them shorn so close as to kill out the strongest plantings while young. Shallow planting, thin soil, standing water on the surface, grass and weeds to smother the plants, are all to be avoided or remedied. In short, avoid everything that interferes with a good stand and a vigorous growth, and you will never have cause to call the white willow a humbug. * * *

The amount of fuel that may be cut from a rod of fence, taking all above the height of three feet, is much greater than most persons would think, and its reproduction on the same spot, without further labor, makes it a crop of no mean value on the open prairie. * * *

Objections answered.—It is urged against the willow hedge, that it occupies too much space, shading and damaging crops near it by sapping moisture from the adjacent grounds. It must be admitted that for one or two rods on each side of the row, after it has made a few years' growth, cultivated crops will be affected by it, and that corn will not produce a full crop within say thirty feet of the trees. Granting this, still I have never found a farmer who did not claim that the protection of the ground for ten or twenty rods further did not cause such increase as to more than counterbalance the other effects. Again, the ground occupied is paid for over and again by the permanent fence obtained, and by the timber that may be taken from it through an indefinite time. Other objections, such as ragged rows of trees, sickly growth, &c., are answered above by the showing that they may be, and should be, guarded against.

In answer to questions the above writer replied, giving some further information about the willow as a fence and screen. He thought six years would be sufficient to grow a fence strong enough, without weaving in or plashing, to turn stock. The willow was injured by two kinds of worms, but recovered without apparent damage.

In this connection it may be proper to offer some facts concerning the willow as a timber-tree, and as a plant useful for cultivation for various uses in the arts. Of course it should not displace more valuable kinds, but it may be grown where these might not succeed.

OTHER USES OF THE WILLOW.

The value of the larger willows for lumber, &c., is scarcely yet realized in this country. In England four species are found especially valuable for certain uses. They are—

1. *Salix alba*, the white or Huntingdon willow, a fine tree which in proper soil will, in twenty years, make an average of two cubic feet a year. The wood is light, tough, easily worked, and proper for tool-handles, hoops, cooper work, &c., and its bark is used for tanning, and in medicine as a tonic and astringent, being recognized in our pharmacopœias, and sometimes used as a substitute for Peruvian bark. Its active principle, *salicin*, is also used as a remedy in intermittent fevers. This willow has been already widely introduced, and in the prairie region of the Northwest it is valued above all other trees as a wind-break. It makes a very good fuel, and its wood is useful for a great variety of purposes.[1]

2. *Salix Caprea*, the goat-willow or saugh-tree, grows to a large size; its wood is tough and elastic, and takes a fine polish. It is worth in market about as much as the birch, or the larch. Its bark it used for tanning.

3. *Salix Russelliana*, the Bedford willow, grows rapidly, attains a large size, and its wood is deemed equal to that of the white willow, and by some superior.

4. *Salix fragilis*, red-wood willow. This has a light, tough, and durable wood, and grows to a large size, but when old is liable to die in the top. Its heart-wood is reddish, from whence the common name. Its specific name is given from the facility with which the twigs used for basket-work break from the tree. The twigs themselves are tough and pliable.

Besides these species, worthy of notice for their woods, the osier-willow (*Salix viminalis*) is an important article in commerce for basket-making, and the *Salix lanceolata*, largely used in Europe for hoops. The following article by M. Hanson, upon the cultivation of this willow in Norway, abounds in useful information, and is suggestive of ideas applicable in our own country:[2]

It is now some six years since I began the cultivation of the native willows, especially the *Salix fragilis*, which grows very thriftily in some of our northern districts, and which I hoped to make useful. After having planted many stocks, both in marshy grounds and elsewhere, I found that although this willow grew well it did not render the services which I had expected. I then turned my attention to the Dutch osier

---

[1] Professor Sargent mentions a willow between Stockbridge and Great Barrington, Mass., planted, it is said, as a cutting in 1807, that now, at 4 feet from the ground is 21 feet 8 inches in circumference.

[2] An English writer in speaking of the willows, says that the white willow, when unpruned and grown naturally in favorable conditions, is the handsomest of the willow family, whether we regard its general outline, habit, or the peculiar whiteness of its foliage, which forms a pleasing contrast with the darker green of other trees. It comes forward rapidly on deep river banks and rich alluvial bottoms, too damp for most other timber-trees. In Great Britain within a few years willow timber has come universally into use as blocks for brakes in railroad cars, so that wood of good size has become scarce and high-priced. The charcoal of all willows of suitable size is used in making gunpowder. Among other uses to which certain kinds of willow are used in Europe, and for which it is especially adapted, are paddle-wheel floats, and for shrouding water-wheels, cart-linings (being not liable to splinter), turner's uses, shoe-lasts, withes for tying, &c. Something has been said of its incombustible properties, but more than facts will justify.

[2] Plantations of Willow in Norway, by M. Hanson (of Stavanger), read before the *Soc. Imperiale Zoölogique d'Acclimatation*, of France, December 15, 1865, and translated from their *Bulletin*, 2d ser., ii, 727.

(*Salix lanceolata*) which is used in cooperage, and procured from Holland a thousand stocks, hoping that I had here found an osier capable of being utilized, but my experiments gave me only a very imperfect material for the making of barrel hoops, and the cost became so great that I abandoned the experiment. I then procured other specimens of the *Salix lanceolata* from Hamburg, and these now constitute my nursery. As my first trials gave me a certainty of result in osiers as good as those of Holland, and which in three years were quite suitable for use, I established, with the aid of the Norwegian Government, a larger nursery, and our consul-general at Amsterdam received through our government an order for 5,000 stocks of the true *Salix lanceolata*. I also procured from England several kinds of osier very suitable for basket-work, *palm-pile, menings-pile*, and *oesoer-pile*. These osiers are very good for small hoops and heavy basket-work, while for the finer work in basket-making I have obtained useful results from the *Salix purpurea* and *Salix viminalis*, of Germany, *Salix Americana*, and others. I have thus embraced fifteen species of osiers in my cultivation.

My design in establishing a plantation of osiers has been to prove their utility and profits in such a way, that the small proprietors of the country can be benefited by their imitation. Our district, from its fisheries, consumes a great amount of basket-work and cask-hoops, and Stavanger alone has occasion for half a million of barrels in a year. As each of these requires a dozen hoops, it is easy to see what an interest the production of osiers is to our country, and I am surprised that an object of so great utility has not long ago been made a subject of experiment. The affair since my labors have been commenced has excited much interest in this country, since it has demonstrated conclusively that we can here produce osiers suitable for hoops. As a proof of this, I have received within the last six months orders for 25,000 roots from the country people, and nearly 50,000 from wealthy proprietors. My manner of reproducing the osier is very cheap and simple. In November and December I cut all the strong branches to a length of about 25 inches. The cut is as smooth as possible, and always beveling. The slips are kept in a cellar protected from frost with the bottoms set in wet *sphagnum*.[1] By moistening the ends from time to time with water, not only are the buds kept fresh through the winter, but even the roots begin to develop. In this way the buds are more vigorous and grow faster than they would if cut in the spring, as is the usual practice. In the spring, when the ground is prepared by forming ridges in the wet soil or digging trenches in the dry soil, I begin the plantation. In poor marshy grounds where these ridges are made, I plant the slips from one to two aunes apart in one direction, and 30 to 40 inches the other; but in good dry ground I plant 20 inches apart in one direction and 40 in the other. This planting is done as follows: We first draw a line across the field we wish to plant, and along this cord we form a ditch about 18 inches deep, into which we put the slips in such a way that those who plant may with one hand press in the slip, while he takes the distance with the other. When the slips are all placed, we fill the ditch half full with the earth that has been thrown out, and then throw some manure from the stable between the slips, but without touching them, and then fill up the rest of the trench with soil. We then establish another line parallel with the former, and proceed in like manner. After the planting is done, we water all the slips with manure water, diluted with twice its quantity of common water, a proceeding that is absolutely necessary in our poor soils, because, as the roots have been already formed, they must have nourishment at once, and the manure that has been buried with them cannot supply it until after some time. After trying various experiments, I have come to adopt this method of management with the very best results. At the end of five months my slips will have grown more than five aunes (about 10 feet) in length, which is an exceptional result in our country, where the climate is very rude and exposed to every wind. In making my first experiments I selected a plot of ground such as experts would have thought the very poorest in the neighborhood. I have in my nursery about 15,000 roots.

The slips are planted somewhat inclined, with the leaning slope turned to the north, for if it was set toward the south it would be injured by the action of the sun and the rain. The solar heat is more useful when it falls upon the longest side, which is turned to the sun. In dry soil we do not make ridges, but set the plants from 21 to 22 inches in the ground, as the wind would uproot them if set at a less depth. The shoots are allowed to grow without hinderance the first year. The above management is that for the willows intended for cask-hoops. When planting for basket-work we must proceed as follows: I form hedges around the other willows, the plants being 12 inches apart, and where the ground is deep enough, and where it is necessary to guard against the north or west winds, which are very injurious to the plants, I make an embankment of turf, which also serves as a defense against cattle. These banks are about 2 aunes (4 feet) high and about 20 inches wide at the top. The central part is of soil covered with living turf and fixed by willows, the roots of which penetrate into the interior and are a further shield against the violent winds which often prevail. The soil for this bank is taken from the interior so as to form a ditch and thus present

[1] Peat-moss.

a further obstacle against cattle. This wall is very useful to the hedge, and a hedge thus protected in three years attained a height of 6 or 7 aunes (12 to 14 feet) and afforded a shelter for my whole nursery against the winds. It was necessary to cut it off frequently all along the south side, on account of its shading the grounds. This is the most economical method of protecting such a plantation against the violence of the winds.

The willow family embraces an immense number of species, mostly thriving in cold climates, and it grows in polar regions on the extreme border of vegetation. It is found sparingly in Barbary, and there is one species in Senegal.[1]

The species generally cultivated for basket-making is the *Salix viminalis* of Europe.[2] It can be raised to advantage only in low, level, and moist soils, properly drained and prepared, and it is desirable that means should be had for irrigation, especially if the soil is calcareous or siliceous. If poor, the soil should be well manured, as for a crop of grain. The planting may be done in autumn or early in spring, by cuttings square at the lower end, so that the roots may come out equally all around, and sloping above, to shed rain. They should be of one-year-old wood, from 12 to 16 inches long, and the larger the better, thrust vertically down three-fourths of their length, and the soil firmly pressed down with the foot. They should be hoed flat, and be kept perfectly free from grass and weeds. They should be set a foot apart, in rows 18 inches apart, and be cut close to the root every fall after the leaves have fallen. If not peeled at once, they should be tied in bundles standing upright in water two or three inches deep till spring; or they may be steamed and peeled in winter; but steaming injures their color and lessens their market-value.

A serious injury is sometimes experienced from the larvæ of a saw-fly—the *Nematus ventralis* (Say.)—closely allied to the currant-worm, which strips off the leaves, and greatly injures the plant. Its proper remedy is the dust of white hellebore, and the destruction of eggs whenever they can be found.[3] In France, the osier is sometimes injured by a small insect on the under side of the leaves. The bind-weed is, however, most dreaded, as it loads down and greatly injures the shoots.

The osier may be injured by late spring and early autumnal frosts, and the latter in cold climates is very apt to injure the young wood while it is still herbaceous, of course killing it thus far. A plantation once started and properly cared for should last many years—sometimes

[1] The study of willows has been made a specialty by some naturalists, who find therein an ample field for research. Linnæus described 31 species, many of them Arctic; Pursh, 37 from North America alone; Willdenow, 116; in Rees's Encyclopedia (1819) we find 141 species described, and Loudon has 282. Professor Torrey, in editing "Lindley's Natural System," in 1831, credits 51 species to North America, and in 1843 had found 16 species growing in the State of New York. West of the Mississippi we do not find a great variety, there being but 6 mentioned in the Survey of the Fortieth Parallel, and only 4 in Professor Newberry's Reports in the Pacific Railroad Surveys. There is no end to poetical allusions to the willow. They are found in the literature of all languages and of all periods.

The osier-willow is an important article of manufacture in England, where, besides the large production, about 5,000 tons a year, worth about £46,000, are imported from abroad. Efforts have been made for several years to introduce its cultivation into Australia.

The great variety of uses to which the willow is applied has led to the careful selection of varieties, and their multiplication by grafting, layer, and cuttings, so that the English distinguish not less than 300 varieties. Mr. Scaling, of Basford, near Nottingham, has the most important plantations in that country.—(*Bulletin de la Soc. d'Acclimatation, June,* 1874, 420.)

[2] Among other species, the *Salix vitellina, S. rubra, S. korbyana, S. decipiens, S. stipularis, S. triandra, S. helix,* and *S. purpurea* are sometimes used for basket-work.

[3] *Patent Office Report:* Agriculture, 1853, p. 207. *Annual Report of Department of Agriculture,* 1873, p. 254, giving a particular account of the ravages by the saw-fly.

forty or fifty, while others, by neglect, will run out in seven or eight.[1] They should arrive to good condition the first year. The crop will range from two to five tons, green, to the acre. They should be cut annually—the first year being of little or no value.

Mr. O. B. Galusha, in a lecture at the Illinois Industrial University in 1869, in speaking of the white willow, says:

I regard this as probably combining more desirable qualities for cultivation in groves for lumber purposes than any other variety of the soft-wood, rapid-growing deciduous trees, and am decidedly of the opinion that this and the golden variety are the best deciduous trees within my knowledge for wind-breaks or screens, but wish to be distinctly understood as not recommending this tree as a hedge-plant, or the planting of this or any other one sort to the neglect of other desirable varieties. Strong cuttings of this tree seldom fail to strike root at once in mellow soil, and will make a growth of from two to six feet the first season. It thrives in all kinds of soil, making as much wood in a given number of years as any other known sort, not even excepting the cottonwood, growing into a large tree, sometimes four feet in diameter. The wood is of rather fine texture for a light wood, making a fair article of soft lumber, which bears a fine polish. It is also valuable for making wooden ware, bowls, trays, &c. It also splits freely, which is a desirable quality in making fence-posts, rails, railroad-ties, and fire-wood. * * * The golden willow is similar in growth and texture to the white, but I think does not make so large a tree. I have measured about a dozen trees of this variety (golden), which were planted by the roadside 15 years ago last spring, and find the average circumference of the trunks at three and a half feet from the ground to be 5 feet 3 inches. A white willow * * * which has grown from a small cutting put in 13 years ago last spring, now measures 6 feet 2 inches near the ground, forming a head or top 30 feet across. This variety, when planted in groves, grows tall and almost perfectly straight. I have carefully computed the expense of raising ten acres of trees of this variety and converting them into lumber, and find the entire cost not to exceed $10 per thousand feet. This estimate is based upon actual measurement of the growth of trees. The land itself is valued at $40 per acre, with interest upon this amount, together with expenses computed as before, at 6 per cent. compound interest. I take ten acres in these estimates of growing artificial groves because it is desirable to have trees enough together, or in close proximity, that the cost of putting up and removing a saw-mill would be but a trifle upon each thousand feet of lumber sawed.[2]

The value of the willow in preventing erosion in the banks of rivers and streams, for holding the soil liable to washing away in valleys, and for filling up the channels worn by small streams in loose gravelly soil, and preventing further gullying, must have been noticed by every observing person. This office is performed by the multitude of long tracing roots that it sends through the damp soil wherever they find nourishment, the shoots by which it multiplies and spreads from the roots, and sometimes when crowded, by the prostrate branches.

Such willows, when abundant and of large growth, also serve a useful purpose by preventing injuries from floating ice in rivers, and they are

---

[1] *Traité pratique de la Culture de l'Osier, et de son usage dans l'industrie de la Vannerie, fine et commune.* Par A. Moitrier. Paris (1855), p. 17. See also *Guide Pratique de la Culture du Saule, et de son emploi en Agriculture, notamment dans la creation des Oseraies et Saussaies, avec un appendice sur la culture du Roseau.* Par M. J. Koltz. Paris, 1867. 18mo. p. 144. *La Salicicnlture et la Vannerie.* Par —— Buffant-Curé, Langres, p. 31.

Mr. Scaling, of Basford, near Nottingham, England, has also written an admirable treatise on the osier-willow. A synopsis of his methods, prepared by the Commissioner of Agriculture (Hon. Frederick Watts), is given at pages 419–426 of the monthly reports of the Department of Agriculture for 1873.

It is stated that between 6,000 and 7,000 acres are cultivated in England and Ireland, and that 4,400 tons are imported into Great Britain annually at a cost of $218,045, besides baskets worth $224,200. Contrary to the belief of many, the willow does not require a swampy soil, but will grow on any land not too dry, and often yields a greater profit than the ordinary farm-crops. As a rule the osier is tougher when grown on strong loam inclining to clay, but the *Salix helix*, or rose-willow, becomes scrubby and poor in such soil. The varieties of willow cultivated are many. Dr. Host, of Vienna, is said to have cultivated over 300; the Duke of Bedford, at Woburn Abbey, 250, and the nursery at Basford over 300 varieties.

The details published in the reports of 1873, above cited, would be very instructive to those in quest of fuller information upon this subject.

[2] *Second Annual Report of Trustees of Illinois Industrial University*, p. 355.

turned to profitable use by engineers for holding in place the new deposits of mud formed under the shelter of jetties and other hydraulic improvements.

The roots of cottonwoods and willows have a habit of seeking the water of wells and water-pipes, and of choking them up entirely by the thick mat of roots that they throw out. We have known such a mass 6 feet long, and of the size of the well, cut out with sharp spades and drawn to the surface.

STATISTICS OF THE USE OF WOOD BY RAILROADS AS FUEL AND FOR TIES.

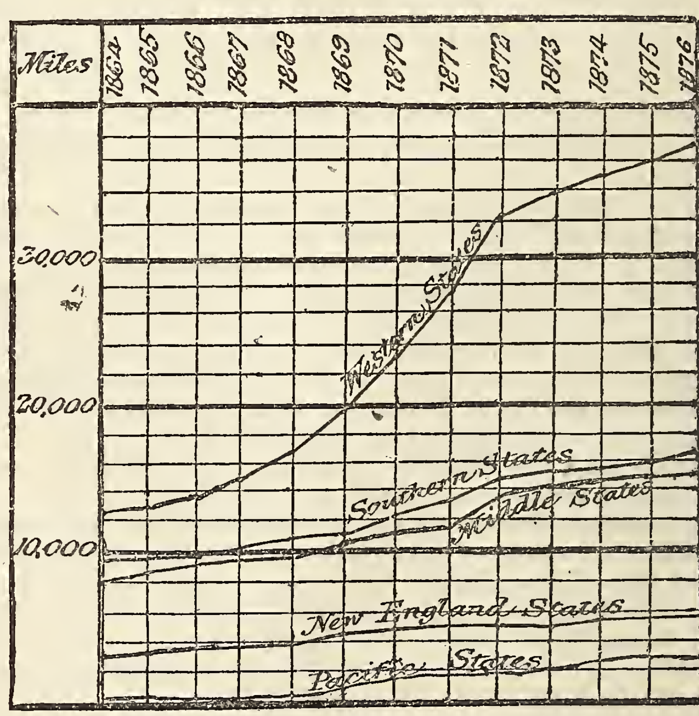
The building and maintenance of railroads involves a large demand for timber, and the supply of these wants by cultivation must in future engage the attention of the companies by which these lines are owned, as is already the case with several of them in the Western States and on the Pacific Coast. The extent of railroads has more than doubled in the United States since the late war, as will be seen by the following table:

Railroads in the United States at the end of each year since 1864.

Years.	New England States.	Middle States.[1]	Western States and Territories.	Southern States.[2]	Pacific States.[3]	Total.
	Miles.	*Miles.*	*Miles.*	*Miles.*	*Miles.*	*Miles.*
1864	3, 793	7, 941	12, 497	9, 511	166	33, 908
1865	3, 834	8, 539	12, 847	9, 632	233	35, 085
1866	3, 868	9, 144	13, 621	9, 867	327	36, 827
1867	3, 938	9, 555	15, 226	10, 126	431	39, 276
1868	4, 019	9, 765	16, 889	10, 683	889	42, 255
1869	4, 301	10, 752	19, 884	11, 107	1, 164	47, 208
1870	4, 494	10, 991	23, 540	12, 196	1, 677	52, 898
1871	4, 898	12, 380	28, 269	13, 246	1, 765	60, 568
1872	5, 053	13, 499	32, 112	14, 112	1, 959	66, 735
1873	5, 314	14, 019	33, 905	15, 353	2, 193	70, 784
1874	5, 509	14, 291	34, 954	15, 602	2, 339	72, 695
1875	5, 638	14, 740	35, 802	15, 919	2, 514	74, 614
1876	5, 694	15, 085	37, 055	16, 676	2, 960	77, 470
1877	5, 812	15, 483	38, 137	16, 999	3, 251	79, 682

[1] N. Y., N. J., Pa., Del., Md., and W. Va.
[2] Va., N. C., S. C., Ga., Fla., Ala., Miss., La, Tex., Ark., Tenn., and Ky.
[3] Nev., Cal., Oreg., and Wash.

The relative amount of railroads in different sections of the Union is shown in the accompanying diagram.



Miles of railroads in different years.

A circular was addressed in March, 1877, to the superintendents of railroads with the view of obtaining facts and the results of experience in regard to the use of wood as fuel, and the kinds of timber used as ties, with statements as to relative durability and as to the results of experiments that might have been tried with the view of rendering them less liable to decay. Returns were received from 38 companies, representing 8,782 miles of railroad and about 11,500 miles of track.

Railroads replying to circulars of inquiry.

Number.	Railroads and their termini, branches, &c.	Length in miles.	Length of track.	Total number of engines.	Wood-burning engines.	Fuel used, and remarks.
1	Chicago and Alton Railroad (with several branches and extensions to Kansas City, &c.)	612	784	156	9	Oak, costing $2 per cord.
2	Chicago, Burlington and Quincy Railroad (with leased lines, viz, Saint Louis, Rock Island and Chicago; Chicago and Council Bluffs; Saint Louis and Quincy, &c.)	1,613	1,664	336	0	Wood used only for kindling; oak and hickory for heating.
3	Cleveland and Pittsburgh Railroad. (Cleveland to Wellsville, operated by Pennsylvania Railroad, river division, 68 miles; Tuscarawas branch, from Bayard to New Philadelphia, 32 miles.)	200	264	97	0	Oak, hickory, and beech for heating; oak preferred; $1.30 per cord.
4	Columbus and Hocking Valley Railroad. (Columbus to Athens, 79 miles; branch from Logan to Straitsville, 13 miles.)	92	116	31	0	Oak, ash, elm, hickory, and hard maple, for kindling; preferred in the order named; $2 per cord.
5	Connecticut Valley Railroad. (Hartford to Saybrook.)	46.4	52	7	0	Oak and chestnut for kindling, $3.75 per cord.
6	Cumberland Valley Railroad. (Harrisburg, Pa., to Virginia shore, Potomac River.)	82	101	21	8	Hickory and oak, $3 per cord; one cord will run a train 52 miles.
7	Dakota Southern Railroad. (Sioux City to Yankton, Dak.)	61	64	4	0	Cottonwood, $2.20 per cord; coal, $4.28, one ton running 46 miles.
8	Delaware, Lackawana and Western Railroad. (Morris and Essex division, 84½ miles; Boonton branch, 34¼ miles; Chester branch, 10 miles; Newark and Bloomfield branch, 4¼ miles.)	133	238	111	8	Oak and chestnut only; oak preferred, $3.50 per cord, one cord running 32½ miles.
9	Detroit and Milwaukee Railroad of Michigan. (Detroit to Grand Haven.)	189	219	37	30	Oak, beech, maple, and elm; beech and maple preferred; cost $2 per cord; one cord will run 40 miles.
10	Dubuque and Southwestern Railroad. (Farley to Cedar Rapids.)	55	59	4	0	Oak, costing $4 per cord.
11	Eastern Kentucky Railway. (Riverton to Willard, Ky.)	34	37	5	0	
12	Erie Railway. (Main line owned, 429.14 miles; main line leased, 30.89; branches owned, 96.64 miles; branches leased, 359.88 miles; branches operated, 39.22 miles.)	956	1,818	468	0	Wood used only for kindling, &c.; costs $3.89 for whole road.
13	Evansville, Terre Haute and Chicago Railway. (Terre Haute to Dansville, Ill., 55 miles; 8 miles siding.)	55	63	7	0	Wood for kindling; costs $1.50 per cord.
14	Fort Wayne, Jackson and Saginaw Railroad. (Fort Wayne to Jackson, Mich.)	100	108	10	10	Beech and oak; costs $2.80 per cord, cut in 2-foot lengths; one cord will run 50 miles.
15	Grand Rapids and Indiana Railroad. (Northern division and Traverse City branch. Grand Rapids to Petoskey and Traverse City.)	218	236	17	16	Beech and maple, costing $2; one cord will run about 50 miles.
16	Knox and Lincoln Railroad. (Bath to Rockland, Me.)	49	52	5	4	Hard wood, $4; soft wood, $3; one cord will run a train of two to four cars about 50 miles.
17	Lake Shore and Michigan Southern Railway. (Main line, Buffalo to Chicago, 570.37 miles; 9 branches, 324.23 miles; 3 proprietary roads, owned wholly, 160.11 miles; 3 roads operated under lease, 150.68 miles; second tracks, 230.80 miles; side tracks, 446.70 miles.)	1,175½	1,852.9	495	110	White oak, beech, and maple; average cost, $3.75; one cord will run 48 miles. Amount of fuel used: wood, 87,236 cords; coal, 261,719 tons. Michigan division reports as used, beech, birch, elm, maple, white oak, and hickory for first class; red oak, sycamore, tamarack, &c., for second class; and basswood, cottonwood, ash, whitewood, and pine for third class; cost, $3.50 to $4. One cord on this division runs 51 to 53 miles.

Railroads replying to circulars of inquiry—Continued.

Number.	Railroads and their termini, branches, &c.	Length in miles.	Length of track.	Total number of engines.	Wood-burning engines.	Fuel used, and remarks.
18	Logansport, Crawford, and Southwestern Railway. (Logansport to Terre Haute, Ind.)	116	123	8	0	Wood for kindling costs $2 per cord.
19	Louisville and Nashville and South and North Alabama Railroads. (Louisville and Nashville Railroad: Louisville to Bowling Green, to Nashville; Clarksville division, Bowling Green to Paris; Memphis division, Paris to Memphis; Nashville and Decatur division, with branches. South and North Alabama Railroad: Decatur to Montgomery, Louisville, Bardstown, Richmond, Livingston, Glasgow, Cecelia, Memphis, and Montgomery.)	967	1,089	204	0	Oak, ash, hickory, pine, and beech for kindling; cost, $2.50 to $3.
20	Marietta, Pittsburgh, and Cleveland Railway. (Marietta to Canal, Dover, Ohio.)	100	....	......	......	Coal used exclusively, being abundant and cheaper.
21	New Haven and Northampton Railroad. (New Haven, Conn., to Williamsburg, Mass., and branch to Holyoke.)	109	134	20	0	Wood for kindling, chestnut, pine, and hemlock, costing $3 per cord.
22	Northern Central Railway. (Baltimore division: Baltimore to Marysville, Pa.)	91	195	55	0	Oak and chestnut, used for kindling; oak costs $3.25 and chestnut $2.50 per cord.
23	Baltimore and Potomac Railroad. (Baltimore to Washington, 42.6 miles; branch to Pope's Creek, 48.7 miles.)	91	107	33	0	Oak and pine for kindling; oak, $2.50; pine, $2.50 per cord.
24	Alexandria and Washington Railroad.	6	6¼	......	......	Wood used only for kindling.
25	Alexandria and Fredericksburg Railroad.	34	36	3	0	Do.
26	Connecticut and Passumpsic Rivers, Massawippi Valley, and Southeastern Railways. (Sherbrook to White River Junction, 145 miles; branch from Newport, Vt., to West Farnham, 65 miles.	210	225	28	28	Wood of all kinds used, costing $3 per cord.
27	Philadelphia, Wilmington and Baltimore Railroad. (Philadelphia to Baltimore, 96 miles; Wilmington and Delaware Railroad, 97 miles.)	193	359	82	0	Wood only for kindling.
28	Port Royal Railroad. (Augusta, Ga., to Port Royal, S. C.)	112	115	10	10	Yellow pine, with very little sap; not over 1½ inches, average 2-foot wood; cost, $1.87½, and will run about 25 miles to cord.
29	Providence, Warren, and Bristol Railroad.	35	37	3	0	Wood only for kindling.
30	Richmond, Fredericksburg, and Potomac Railroad. (Richmond and Quantico, Va.)	82	....	10	9	Pine mostly used, costing $2.10; a cord runs 40 miles.
31	Saint John's Railway. (From Tocoi, on Saint John's River, to Saint Augustine, Fla.)	9	9¼	2	2	Pitch-pine; $2 per cord. One cord will run 100 miles. [Light engines, 9 and 12 tons.]
32	Saint Louis and Southeastern Railway. (Saint Louis to Nashville, with branches of 7 and 42 miles.)	365	....	63	0	Wood used only for kindling.
33	Sheboygan and Fond du Lac Railroad. (Sheboygan to Princeton, Wis.)	78	....	5	5	Maple, ironwood, oak, ash, basswood, and tamarack, worth $2 per cord. One cord will move a train 46.6 miles.
34	Southern Minnesota Railway. (From La Crosse to Winnebago City.)	170	184	14	0	No wood used except for kindling.
35	Staten Island Railway. (Vanderbilt Landing to Tottenville, N. Y.)	13	13.4	4	0	Wood only used for kindling.

Railroads replying to circulars of inquiry—Continued.

Number.	Railroads and their termini, branches, &c.	Length in miles.	Length of track.	Total number of engines.	Wood-burning engines.	Fuel used, and remarks.
36	New York, Providence and Boston Railroad. (Providence, R. I., to New London, Conn.)	26	26	......	......	Burn coal altogether, except for kindling.
37	Western and Atlantic Railroad. (Atlantic to Chattanooga.)	138	208	50	2	Oak used, because more plentiful and cheaper; costs $1.50 per cord.
38	Western Railroad of Alabama. (Selma to West Point, 138 miles; Opelika to Columbus, 29 miles.)	167	174	19	3	Will change to coal burners entirely in 1877. Fuel, pine and oak, $2.50.

Number, cost, and size of Ties used on Railroads.

Number.	Number to a mile.	Cost.	Dimensions. Length.	Width.	Thickness.
		Cents.	*Feet.*	*Inches.*	*Inches.*
1	2, 640	40	8	8	6
2	2, 600 to 3, 000	45	8	8	6
3	2, 600	40 to 50	8½	8	7
4	3, 000	40	8	8	6
5	2, 640	22 to 40	8	8	6
6	2, 400	55	8	8	7
7	2, 740	50	8	8	6
8	2, 700	47	8½	6	6
9	2, 640	†18 to ‡30	8	8	6
10	2, 640	50	8	8	6
11	2, 600	....	8	8	7
12 *	....	....	....	....	....
13	2, 640	30	8	8	6
14	2, 500 to 3, 000	30 to 35	8	8	6
15	2, 600	†17 to ‡30	8½	8	6
16	2, 420	(§)	8	6	6
17	‖3, 000	30 to 50	8 to 9	6 to 7	6
18	3, 000	33	8	10	6
19	2, 600	30	8½	9	6
20	....	....	8½	8	7
21	2, 640	....	8	7	6
22	2, 816	60	8½	7	7
23	2, 816	30 to 50	8½	7	7
24	2, 816	30 to 50	8½	7	7
25	2, 816	30 to 50	8¼	7	7
26	2, 200	20	8	7	6
27	2, 640	45 to 55	8	7	6
28	2, 348	25 to 30	9	10	6
29	3, 520	53	8	7	6
30	2, 500	37½	8	8	6
31	2, 200	25	8½	9	7
32	2, 400	25	8	8 to 11	7
33	2, 600	25 to 30	8	6	6
34	2, 600	40	8	7	6
35	2, 600	55	7½	8 to 10	6
36	....	....	8	....	6
37	2, 600	35	7	9	8
38	2, 640	30	9	9	7
39					

* See subsequent table. † Hemlock. ‡ Oak. § Hemlock, 25; hickory, 30; oak, 35, and cedar, 35 to 40.
‖ Michigan division.

Remarks upon the kinds and qualities of timber used as ties, the time of cutting, preserving processes, &c.

[The numbers at the beginning of each paragraph, refer to the railroad as numbered in the preceding table.]

1. White and burr oak used, lasting 8 years.

2. White and burr oak used, lasting 9 years. Experiments have been made with cedar and catalpa, but no results yet obtained. Ties cut in the winter last a year longer, and we add another year of life by peeling the bark. Used a creosoting process for some hemlock ties, but it did not appear to make much difference.

3. White-oak ties accounted best. They last 6 to 7 years. They are cut at all seasons, but best from October to January.

4. White oak and chestnut used, lasting about 7 years (with steel rails, which require less changing of spikes than iron). The ties are cut at all seasons, and no observations with respect to durability have been made.

5. Chestnut ties will last about 8 years. They are mostly cut in the winter months, and are better than when cut at other seasons.

6. Ties chiefly white oak, chestnut-oak, and walnut; mostly cut in winter.

7. Ties made of ash, rock-elm, cottonwood, and red elm, lasting 5 years, except cottonwood, which lasts but 3 years. They are best when cut from January 1 to March 1.

8. White and rock oak and chestnut are used for ties. The oak is superior in durability, lasting 8 years; chestnut, 7 years. They are cut in winter, but no comparison has been made as to durability of ties cut at different seasons.

9. Ties in use of oak and hemlock, lasting on an average 6 years. They are best when cut in December and January, but no experiments have been made to test durability.

10. White and burr oak principally used; red oak and red elm to some extent. The two former will last about 8 years; red oak, 4 to 5 years; and red elm, 6 to 7 years. The ties are cut principally in winter. Have begun to take off the bark before using.

11. White oak used for ties, and found more durable if cut in January rather than any other month, so far as observed. They decay soonest if cut in June, July, or August.

12. This company classifies the timber used for cross-ties as follows:

First class. Second growth chestnut, white oak, burr oak, rock oak, yellow oak, black locust, and mulberry.

Second class. Butternut, cherry, red cedar, white cedar, yellow cedar, southern cypress, black elm, rock maple, black oak, pitch pine, and black walnut.

Third class. Black birch, first growth; chestnut, northern cypress, red elm, white hemlock, soft maple, red oak, tamarack, and yellow pine.

In purchasing, they are classified according to size (6 by 8 or 6 by 7 inches), and as sawed or hewn, and the bark off or on. They are all 10 feet long, the gauge of the road being 6 feet. They cost according to locality, and grade from 25 to 75 cents.

Average number, price, and life of cross-ties used in the track of the Erie Railway and branches amd season for cutting ties, as reported by the Division Superintendents, April, 1877.

Division.	Number of ties to 1 mile of track. Main track. Main line.	Main track. Branches.	Side track.	Average price. 1st class.	2d class.	3d class.	Average life in main track. 1st class.	2d class.	3d class.	When cut.
				Cts.	*Cts.*	*Cts.*	*Yrs.*	*Yrs.*	*Yrs.*	
Eastern division	3,000	2,710	2,640	60	....	....	7	....	......	Fall and winter season.
Delaware division	3,000	2,900	2,800	$46\frac{2}{3}$	....	....	*7	...	......	December, January, and February.
Susquehanna division	2,800	....	2,640	60	....	....	7	5	$3\frac{1}{2}$	November to February.
Western division	3,000	3,000	2,400	$42\frac{1}{2}$	30	25	†10 to 15	....	6	November to April.
Buffalo division	2,933	3,000	2,581	55	50	$32\frac{1}{2}$	10	‡6	3 to 4	November to March.
Rochester division	2,933	3,000	2,581	55	50	$32\frac{1}{2}$	10	6	3 to 4	Do.
Average	2,944	2,922	2,607	†53	†43	30	†8	6	4	

* Oak, 8 years; chestnut, 6 years.

† This estimate is so large that it is not considered in making up the average.

‡ Cherry and chestnut, 7 years; ash, 6 years.

13. Oak, black walnut, and red elm are used for ties. Oak will last 7 to 10 years, walnut 5 years, elm 6 years. They are cut at all seasons, and no difference is noticed as to durability.

14. White and swamp oak are used for ties. Thorough drainage is necessary to insure durability. The ties rot soonest in the cuts. Our road has been running 7 years, and we are replacing ties, using such timber as can be got, many being of ash and hackmatack, &c. They are best when cut in winter.

15. Oak and hemlock are used, the former lasting 7 to 8 years and the latter 5 to 6. They should be cut from December to May.

16. Hemlock, oak, cedar, and hackmatack are used. The first of these lasts but 4 years, and no more are bought. Oak does not meet expectations for durability. They may look sound, but are rotten inside. They are used for curves, and will last 5 years. Old-growth hackmatack ties are good in holding spikes, and last 6 to 8 years. Good cedar ties are the most economical for straight lines and light curves, and most of those 6 by 8 inches that were put in 7 years ago are in fine condition now. They will last for years to come. Ties should be cut in fall and winter.

17. White oak in all respects the best. Average life in track, 9 or 10 years. Cut in winter. The Michigan division reports the use of white or burr oak almost exclusively for ties. The superintendent remarks: "We notice that small trees which will hew to the right size are more durable than ties sawed from larger trees. They are cut, of late years, altogether in January, February, or March. There have been planted on subdivisions of this road the following trees, more for shade than for timber, and as an inducement to farmers to plant, viz: Between Toledo and Butler, Ind., 760 maples, 7 elms, 30 mountain ash, 19 evergreens, 10 chestnut, 1 cottonwood; between Butler and Elkhart, 253 soft maples, 194 hard maples, 16 elms, and 1 sycamore; on Coldwater subdivision, 1,018 maples, 2,353 larch, 2,839 chestnut, 40 elm, 56 Norway spruce, 16 cedar, 30 white pine, 2 mountain ash, 5 white ash, 2 black ash, 12 black walnut, 18 butternut; on Adrian subdivision, 2 ash, 3 basswood, 1,300 chestnut, 11 cottonwood, 61 elm, 2 hickory, 1,161 larch, 803 maple, 2 oak, 2 sycamore, 35 walnut, 83 evergreen. During the last season there were planted on the Jackson branch, between Adrian and Jackson, 592 chestnut, 465 larch, 120 hard maple, and 10 elm trees.

18. White oak; average life, 5 years. Ties cut in winter months.

19. White and post oak used; mountain post-oak preferred. It will last 8 years in rock ballast, 6½ years in gravel ballast, and 4½ to 5½ years in mud bed. They are cut between August 1 and March 1. By cutting when the sap is down two years of life are gained. Hewed ties will last from 1 to 3 years longer than sawed ties, according to the ballast in which they are bedded.

20. For ties we use white oak, chestnut-oak, some locust, but very few of any other timber. Locust is the most durable, lasting (except as they wear out by concussion from the rails) 15 to 20 years. Average duration of good white-oak ties, about 8 years. Ties last best if cut between August and April, and timber cut in spring and early summer is not durable. Under heavy traffic, good ties will *wear out* before *decaying*.

21. Second-growth chestnut used, usually cut in December, January, February, or March.

22. Ties are made of white and rock oak, cut in fall and winter.

23, 24, 25. White and chestnut oaks used for ties. They are cut in fall and winter, and are found to last much longer than when cut in spring or summer.

26. Cedar, tamarack, and hemlock used for ties. Cedar is cheapest and most durable, lasting about 10 years. Ties are cut principally in winter.

27. Chestnut and white oak commonly used. There is not much difference in the two woods, but under high speed (as on this road) white oak probably excels in durability. They are cut largely in winter. No essential difference has been noticed with respect to season when cut.

28. Yellow pine and yellow heart cypress used for ties. We find that the pine lasts about 8 years, and the cypress much longer, but the latter is not adapted to roads with much curvature, owing to its being soft and not holding the spikes well. Ties are generally cut in fall and winter; have also had them cut in summer, and cannot observe any difference as to durability. Round pine is largely used in piling in salt water, and we are much annoyed by a worm that will cut off a twelve-inch pile in four years. We are now trying the experiment of driving piles with the natural bark on, and find it to succeed well, as the worm will not work while the bark remains. We would advise the use of cypress for durability, where it can be used.

29. White chestnut; it lasts about 8 years. Cut in winter.

30. White oak will last 10 years, if it is cut in winter.

31. Black cypress used for ties. The sap rots off in about 3 years, but the heartwood will last 5 to 12 years, according to locality. On low wet ground, covered with dirt, they will last longest. It does not hold spikes well, and they must be driven down four or five times a year. They draw most in summer, and on high dry ground. This wood is cut in winter, and will last twice as long if cut then than in summer. Yellow pine has been tried for ties, but it decays about 20 per cent. a year after the

second year, and sooner if cut in winter. For lasting, we cut our pine timber in June, July, and August, and hew it as soon as down.

32. Hewed white oak used for ties, lasting about 8 years. Cut in winter; none later than February. Ties cut before the sap rises last one-third longer.

33. Oak, hemlock, tamarack, and black ash used for ties. Tamarack and hemlock last 5 to 7 years. Winter is the best time for cutting; cannot get them at any other time.

34. White oak and hemlock used for ties. The former lasts 9 years. Ties should be cut in winter, from November to March.

35. Chestnut in dry places will last 8 to 12 years, and in moist places 5 to 8 years. They are generally cut in the winter months.

36. White oak and chestnut used as ties; cut in fall and winter; use round timber sided.

37. White and post oak used exclusively for ties, lasting 6 to 8 years. They are cut from December 1 to March 1, and when cut in winter will last a quarter longer than when cut in spring or summer.

38. Pine averages 6 to 7 years. Some decay in 3 years, and some fat light-wood will last 15 years or more. On the Memphis and Charleston Railroad, some miles were laid with cedar ties very many years ago, and are still good. We prefer to have our ties cut from January to May inclusive—better in January or February. Experiments were made of impregnating growing pine trees with "dead oil" (distilled from coal-tar at 400° to 600° Fahrenheit), in July, by boring a hole through the tree and making a saw-cut on each side to apply the oil in. It went down more rapidly than toward the branches, and was *irregularly* absorbed by the wood. Was satisfied that this was not the cheapest way to impregnate. Other experiments were tried, leading to the belief that to thoroughly impregnate we must soak long in an open vat, or shorter soaking under pressure. For piling under bridges, we use cedar for light structures, and where it cannot be got *heavy enough*, the choicest pine. As soon as driven the the head is sawn off to its proper length, generally at the level of the ground, and a few holes are bored vertically as deep as the auger will go; these holes are filled with creosote or dead oil, costing 8 to 10 cents per gallon. They are kept filled as the oil soaks in till the trestle is covered by the ground-sill of the work. This method would not of course apply for trestles submerged, but for those across swamps and water-ways, where the top of the piles are very apt to decay rapidly. The object is to get enough of the oil absorbed to protect the portion exposed to alternations of wet and dry. Sufficient time has not elapsed to determine the result.

Remarks concerning screens, timber-belts, and wind-breaks along railroads.

[Numbers refer to railroads, as numbered in preceding table.]

2. Had about 5 miles of willow wind-break near Chicago. They were not kept up. Some farmers are planting Osage-orange hedges along the road, which answers a good purpose.

17. Have about 5 miles of evergreen hedge on Michigan division.

TREE-PLANTING BY RAILROAD COMPANIES.

Several of the railroad companies in the prairie States have undertaken the planting of forest-trees, either as an example for encouragement of settlers, or to promote the sale of lands, or as a source for future supply, or as wind-breaks for shelter to their lines of road. We are unable to present a full list of these experiments, but give the following as containing facts worthy of notice:

Atchison, Topeka and Santa Fé Railroad.—In 1873 this company began to plant nurseries, with the view of forest-growing, at intervals along their line in Central and Western Kansas, under the direction of Mr. S. T. Kelsey. The experiment included the ailanthus, American elm, ash, black walnut, box-elder, burr oak, catalpa, cottonwood, white and gray willows, hackberry, honey-locust, Kentucky coffee-tree, Osage orange, peach, silver maple, and silver poplar.[1] The stations were as follows:

Hutchinson: 180 miles west of Missouri River; 1,500 feet above tide; 18 acres; soil, a light, sandy loam.

[1] Tabular statements of the result were reported by Mr. Kelsey in the reports of the Kansas State Board of Agriculture for 1874, p. 326, and by Mr. C. H. Longstreath, his successor, in the report for 1875, p. 666.

Ellinwood: 215 miles west of Missouri River; 1,760 feet above tide; 17 acres; soil, a stiff, black loam, a little sandy.

Garfield: 256 miles west of Missouri River; 2,100 feet above tide; 17 acres; begun in 1874.

Spearville: 283 miles west of Missouri River; 2,478 feet above tide; 18 acres; soil, a dark loam, with a stiff clay subsoil.

It is observed that the rate of growth from 1870 to 1875 was greatest with the cottonwood at all the stations, and after this the ailanthus, catalpa, and gray willow. As a general rule, the seedlings had done about as well as plants a year old. Of the whole number planted, the greatest number living at the end of the third year was the ailanthus; next to this the honey-locust, catalpa, elm, silver maple, and box-elder, and least the cottonwood, silver poplar, and gray willow. The surviving cottonwoods were 50 per cent. at one station, 25 at another, and 20 at another.

The kinds, on the whole, most approved were the ash, black walnut, box-elder, cottonwood, honey-locust, Osage orange, silver maple, and, for fuel and fruit, the peach. The plantation at Hutchinson, when visited by us in June, 1877, had suffered severely from the locust the year before, which had damaged the ailanthus, apple, silver and Lombard poplar, balm of Gilead, catalpa, and willows very much; in some cases killing them. Elms, maples, and box-elders were less damaged. The Osage orange and honey-locust had been found very liable to injury from gophers, and the peach, to less extent. The rabbits had also proved troublesome. The chestnut and the oaks and hickories generally had failed. The butternut, sapindus, ailanthus, silver and Lombard poplars, and catalpa were still regarded as doubtful, as were the conifers generally. A plantation begun at Syracuse, near the western boundary of the State, had suffered from grasshoppers and drought. The policy now held by the company is, to try hereafter no experiments with species not native of the country, and to employ only such kinds as have been proved well adapted to the climate and conditions of the region through which their road extends.

The report of Mr. Kelsey, at the end of the second year, shows that the apple, golden willow, Norway spruce, and Osage orange had been injured slightly by the winter, the ailanthus, catalpa, and sapindus had been killed back, and the China-tree and some of the ailanthus and catalpa killed entirely.

These experiments derive great interest from the fact that they will determine the capacity of the plains of Western Kansas for forest cultivation, and, to the extent of their success, prove of infinite advantage to the country, by leading to more extended plantations in a region where they are extremely needed.

Kansas Pacific Railroad.—Experiments at tree-planting were begun by this company in the fall of 1870 and spring of 1871, under Mr. R. S. Elliott, at the following stations on the line of this road:

Wilson (now *Bosland*), 239 miles west from Kansas City, 1,586 feet above tide;
Ellis, 302 miles west from Kansas City, 2,019 feet above tide; and
Pond Creek (now *Wallace*), 422 miles west from Kansas City, and 3,175 feet above tide.

The experiments of Mr. Elliott as industrial agent for the company, also included grains and grasses. Of twenty-four species of trees transplanted, six were evergreens and the remainder deciduous kinds, including those that have been most generally cultivated in the Western States. The plantations were neither irrigated, mulched, nor shaded, and were considered as but a rude experiment to test the capacity of the country for tree-planting. They were continued under care about three years and then left, and from neglect, and exposure to stock, have now mostly

disappeared. The results prove nothing beyond the fact that nurseries must be cultivated, and cared for, if we would have them succeed. From two reports of the agent before us, we find but few results worthy of record, as they are mostly occupied with statements of plans. Unfavorable opinions are expressed with regard to the chestnut, larch, poplars, Osage orange, willows, silver maple, Norway spruce, and in fact most of the evergreens, excepting the red cedar and possibly the Austrian and Scotch pines. The black walnut was regarded as doubtful, and the best prospects of success depended upon the cottonwood, ash, box-elder, elms, catalpa, and honey-locust; but the trial was not continued long enough to fairly determine their actual or comparative merits. The experiments were discontinued, not from discouragement or failures in cultivation, and are claimed to have been satisfactory so far as they were carried.

The Missouri River, Fort Scott and Gulf Railroad Company were in May, 1877, preparing to plant 160 acres at Dry Wood water-station, for timber growth. Of this amount 10 acres were to be in locust, 10 in black walnut, 70 in catalpa, and 70 in Osage orange.

The Burlington and Missouri River Railroad Company of Nebraska, at the close of 1875, reported that from 1872 it had planted the north sides of the shallow cuttings at intervals along the road west of Lincoln to the Platte River at Kearney, the ground broken for the purpose, comprising 186 acres, and the length of the plats being 28½ miles; 460,000 trees were planted in 7 rows, the north row being honey-locust for hedge. The other six rows were 7 feet apart, and the kinds used were soft maple, box-elder, sugar-maple, white elm, laurel-leaved willow, cottonwood, and evergreens. The ground was well cultivated, and in the fall of 1873, the following percentages of thrifty life were found: ash, $98\frac{5}{8}$; honey-locust and box-elder, 92; soft maple, 88; evergreens, 81; and willow and cottonwood, 75. The ground was often unfavorable, being the highest points of the prairie table-land, often clay from the cuts, and the banks slacked down exposing the roots. The large failure of evergreens was attributed to the use of 8,000 Norway spruce, which, having never been transplanted, were too weak for the raw soil and exposed location. In 1874, the vacancies were filled with one-year-old native green ash, but an unfavorable season caused some loss. In 1875, the trees made a remarkable growth—cottonwood, 6 feet; willows, 4 to 8, and the honey-locust hedge, having been twice cut back to thicken up, was 5 feet high. The evergreens were well established; in many places the trees were high and thick enough for efficient snow-breaks.[1]

Northern Pacific Railroad.—The land department of this road has an experimental station of forty acres for tree-planting at Casselton, in Dakota, twenty miles west of Fargo. The kinds under cultivation are cottonwood, Lombardy poplar, ash, soft maple, box-elder, white willow, &c. The experiment has been two years in progress, with encouraging prospects.

The Saint Paul and Sioux City Railroad, southwest from Mankato, runs through a prairie country, where tree-planting has been attempted to some extent, and with good success. In 1873 this company, under the

[1] Mr. E. F. Stephens of Crete, Nebr., who had charge of the work, regards the experiment a success; but if the work were to be done again he would confine himself exclusively to native trees, and plant black walnuts. He regards evergreens as reliable growers, and has 3,000 on his grounds, which he managed as well as deciduous trees.—(*Trans. Nebr. St. Hort. Soc.*, 1877, p. 82.)

direction of General J. W. Bishop, set 55,455 cuttings, and in 1874 54,024, in strips 100 feet wide, along the northwest side of cuts where the road had been troubled with drifting snows. These plantings occupy about 100 acres. Some of these plantations are made under the shelter of fences, built for present defense until the trees shall have grown. At Seney, in Iowa, the company has planted 130 acres, chiefly with larch, and in 1876 corn was cultivated among this. The plantation promises well, considering the adverse influences of grasshoppers and drought. During the season of 1877 the company set 100,000 trees, chiefly cottonwoods, and as a wind-break along the line of its road. These are always set with roots, and not as cuttings, and the summer following proved very favorable for their growth.

From Mankato eastward, along the Minnesota River to its mouth, a distance of 80 miles, the country was, when settlement began, covered with a fine growth of timber, having an average width of about ten miles. This timber-belt affords a large amount of fuel for the railroad and for the prairie region to the westward. This company transports trees and cuttings free of charge to all prairie stations, and much interest is being taken by the settlers in planting groves and wind-breaks.

Saint Paul and Pacific Railroad.—Plantations have been undertaken in former years at various points on this road, and nurseries were established at Willmar, Randall, Hancock, Morris, Hermon, Gordon, and Canfield. An interesting account of the plantations undertaken by this company was communicated to the Minnesota Horticultural Society, about two years since, by the Hon. Leonard B. Hodges, of Saint Paul, under whose charge the later operations were executed. The historical as well as practical interest which the subject offers will justify a somewhat detailed notice.

A plantation of 2,000 large deciduous trees in the parks at Litchfield and Willmar, made in the spring of 1870 by the company owning the main line of the First Division of the Saint Paul and Pacific Railroad, failed, and probably for the following reasons: They were "grubbed out" of their native bed and set on unbroken and uncultivated prairie. Some retained vitality enough to leave out, but died one after another, until perhaps a dozen were left. They were planted under contract, at 50 cents each, and were so much loss in money, besides the discouragement from planting which they occasioned.

In the spring of 1872 another contract was let for 7,500 soft maples, box-elders, Lombardy poplars, cottonwoods, and European larches; and in October, 1872, another for 50,000 cottonwoods, Lombardy poplars, and box-elders. The first of these were planted just west of Summit Lake, between the ninety-fifth and ninety-sixth mile-posts, between Atwater and Kandiyohi, on the highest ground between the Mississippi and Red Rivers. The country was a high rolling prairie, with excellent soil and clay subsoil. They were set on the north side of the track, in rows 4 feet apart, and 2 feet apart in the rows. They were well cultivated, and, excepting the larch, made a satisfactory growth. They were injured by weight of snow from drifting of snow-fences, and at the end of 1874 were about eight feet high, and 7,496 were accepted and paid for. Some three hundred or four hundred more than the contract required were set by the contractor, to cover losses. Causes of loss, cattle and snow-drifts.

Of the second contract but 41,500 were planted—about half in cuts between Kandiyohi and Willmar, and the balance on the Pomme de Terre cuts, just east of Morris. This planting was done late, and on ground broken out of season, and on the final estimate, two years after, 18,500 live trees were accepted. The greatest loss occurred with Lombardy poplars, on the Pomme de Terre cuts, and the cottonwoods of this lot did better than could have been expected. They were mostly seedlings, and had their tops killed down to the ground by frost the first winter. On the 1st of June, 1873, they were of the size of young cabbage-plants; at the end of 1874 they are six to twelve feet high, and well proportioned.

During the summer and fall of 1872 about sixty acres were broken up, in strips 25 feet wide, along about fifty of the worst cuts, the outer edge coming to the right-of-way lines of the road, and the inner edge within 50 feet of the center of the track. Many of these strips were planted with acorns in the fall of 1872. Some of these were bad, and the gophers took the rest. Here ended the contract system on the line of this

road, and a tree-planting department was next organized.[1] It was placed under the charge of Hon. Leonard B. Hodges, of Saint Paul, who proceeded to Olmsted County and bought half a million white-willow cuttings, at $2.50 per thousand. Teams and plows were started two days in advance of the planting parties, to prepare the ground for the cuttings, and after plowing and harrowing until mellowed as much as might be, the cuttings were set, between April 23 and May 23, 1873, as deep as they could be stuck, and in isolated tracts from Swede Grove to Breckinridge Flats, a distance of over a hundred miles. The grass and weeds came up with the young willows, and required much care to keep down.

In June and the first days of July 500 acres were broken for future tree-planting, in strips parallel with the road, and on each side of the track, two strips on each side, the first eight to sixteen feet wide, with the right-of-way line in the middle, and from one hundred to one hundred and fifty feet farther back, another strip on each side 25 feet wide.

In September the ground around the rows of trees planted that season was mowed and grass burned to protect from accidental fires. On the 12th of October, 1873, commenced planting white-ash seed on some of the ground between Willmar and Saint John, and by the time the ground froze enough had been planted for a million and a half of trees.

Financial matters, lawsuits, and other circumstances embarrassed operations the next spring, but 115,000 white willows, Lombardy and cottonwood cuttings, were set, and ash and box-elder seed for two millions of trees planted. In the mean time 20,000 European larch plants, two years old, 110,000 plants two and three years old, and 50,000 willow cuttings were obtained from nurserymen, and set, and seeds for some millions of box-elder, ash, white, black, red, burr; and jack oaks, butternuts and sugar-maples, were planted in the fall. The ash seed planted in the fall of 1873 came up with scarcely a failure, and grew twelve to twenty inches. The ash and box-elder sowed in the spring of 1874 had done equally well. At the end of 1874, over half a million of the white-willow cuttings set in 1873 stood from six to fourteen feet high, and were already of perceptible use as wind-breaks, and an equal number of cuttings were got, by thinning these rows, for future planting, leaving as many more that might be taken. The result of two years' planting was about four million young forest trees, in a treeless region. The example of these operations did much to encourage planting by settlers. The great want of cheap cuttings and trees had been met by the company, and plantations of 30,000 and 40,000 trees were made on farms, the enhanced value of lands thus improved presenting a strong inducement for extensive operation.[2]

THE USE OF WOOD IN PAPER-MAKING.

This industry has in recent years acquired great importance, and is rapidly increasing, both in Europe and America. It is more than eighty years since a paper-mill in Fairhaven, Vt., made wrapping-paper from basswood-bark, and about fifty years since Cyprian Prosper Brard, of Frejus, in France, invented a mode of making paper from wood.

From this time down to the present, numerous patents have been granted, both in the United States and abroad, for reducing wood fiber to pulp suitable for paper. Without following these in detail, we will remark, that there are two general methods now in use—the *chemical* and the *mechanical*.

By the chemical process, the wood is cut into chips, then boiled in a

[1] The snow-blockades in the winters of 1871–'72 and 1872–'73, and especially the great storm of January 7, 8, 9, 1873, ever memorable on account of its extent and destructive force, and the misery and death which it occasioned, furnished the most convincing arguments in favor of some effectual means for breaking the force of these storms, and the most urgent motives for the early and adequate planting of wind-breaks.

[2] *Transactions of Minnesota Horticultural Society*, January, 1875, p. 51, in a report made by the Hon. Leonard B. Hodges. It is extremely to be regretted that a change in control and a short-sighted scheme of economy has interrupted these labors, and wholly stopped further operations. Meanwhile, the abandoned plantations, choked with weeds and grass, and overrun by fires, present a sad prospect, and, what is worse, the settlers seeing the enterprise abandoned after so much expenditure, think that there is something wrong in this attempt at cultivation or the company would have continued it. They are therefore discouraged from planting, from fear of failure, and the whole country along the line is suffering in this interest from this reaction.

solution of caustic alkali in close, iron vessels under high pressure of steam, and afterward taken out, washed, and bleached with chlorine.[1]

The American Wood-Paper Company introduced this process at Manayunk, near Philadelphia, some twelve or fifteen years ago, and have continued since. Some other mills have been started upon the chemical process, and we have an estimate of a papermaker well acquainted with the business, that about twenty tons of pulp a day are made, using sixty cords of wood.

The mechanical process most in use, bears the name of Henry Voelter,[2] of Germany, and consists in grinding the wood to a pulp by pressing it against the edge of a broad grindstone. The wood is first cut into lengths equal to the width of the stones, the bark is shaved off, large pieces are quartered, and the pith and knots removed. These blocks are then placed in position, the fiber of the wood parallel with the axis of the grindstone, and firmly pressed against the stone by a screw worked automatically, and descending as the wood is ground away. Four or five of these fixtures for holding the wood are attached to each stone, and water is supplied freely to facilitate the grinding, and to wash away the pulp. This pulp is generally mixed with that from other fibrous substances before being finally made into paper.

The Voelter process came into use about twenty years ago, and was introduced in this country in 1868. A large number of mills have been built in various parts of the country, and are now making, daily, about 100 tons of dry pulp, using for this 200 cords of wood. The timber chiefly used is poplar, and to less extent spruce, pine, basswood, and birch. The fiber from the birch and beech is shorter than that from the pine and fir, and it is whiter, but not as strong.

In Germany, there were about the year 1870 thirty mills for grinding wood into paper pulp. The industry has extended into Russia and other countries where material is cheap, and with the increasing demands for paper, it is probable that the business will largely increase.[3]

It is found at times convenient to be able to distinguish with certainty the presence and proportion of wood-fiber in paper. The microscope will do this to a certain extent, more especially when the coniferous woods have been used. The oval openings or thin places between adjacent cells are generally distinguishable in the fiber when thus examined. But a simple chemical test has been proposed by M. Schachringer, of Vienna, by the aid of analine. Some drops of this, as found in commerce, are placed in a test-tube, to which a little sulphuric acid and water are added, and the whole is heated over a spirit-lamp. A little scroll of paper supposed to contain wood-fiber, if then dropped in, becomes of a lemon-yellow color, more or less intense, in proportion as the wood is more or less considerable in amount.

It is found that wood-fibre is distinguishable in some cases, as to natural orders and genera of the timber used in making it, when carefully prepared and examined under a microscope. The fiber of coniferous

[1] A French patent granted to the Montgolfier Brothers, February 7, 1838, used wood rasped down, steeped in lime-water to soften the wood, ground and boiled in caustic alkali in solution, under pressure. It was then crushed under rollers, reboiled in alkali, and bleached.

[2] The true inventor is said to have been one F. G. Keller, who, in 1844, took out letters-patent in Germany for a wood-pulp grinding machine, but, lacking means, sold to Voelter, and subsequently fell into want, so that the German papermakers came to his relief by subscription.—(*Munsell's Chronology of the Origin and Progress of Paper and Paper-Making*, Fifth ed., pp. 110–114.)

[3] A somewhat extended account of the wood-paper manufacture by both mechanical and chemical processes is given in an article by William R. Patrick, of Marinette, Wis., published in *The Lumberman's Gazette*, vol. xi, p. 133.

woods, when macerated and separated, are long and flat, with dotted places, and bending easily in one plane only. They do not twist and untwist when wetted and dried. The deciduous woods yield a fiber averaging a tenth of an inch long, and a little over a thousandth part of an inch in diameter. They are tubular and pointed, and when freed from intercellular matter, very flexible.

The Japanese Paper Mulberry.—Broussonetia papyrifera.

Visitors at the Exposition at Vienna, in 1873, and at the Centennial Exhibition at Philadelphia, in 1876, had an opportunity of examining articles of paper and papier-maché that were worthy of admiration. The material from which these were made, was the bark of the *Broussonetia papyrifera* or paper mulberry, a tree that grows with great luxuriance where introduced in the Middle States; in fact, multiplying so abundantly by shoots from tracing roots as to become a nuisance when once established.[1]

CHARCOAL—DISTILLED PRODUCTS OF WOOD.

The use of charcoal in the manufacture of iron and other metals, and the various demands for its use in the arts, render this subject an important one in the study of Forestry, and give an interest to every question that may result in improved methods of production or economy in its use. It has not unfrequently happened that a furnace or a forge has proved profitable until the supplies of wood for making charcoal have been exhausted, without attention to the growth of another crop, and it is reasonable to suppose that in future, much more than in the past, calculations upon the capacity of land under given circumstances for the growth of wood, the age, and season of the year at which it should be cut, the kinds of timber most profitable for this use, and the most economical methods of making and using charcoal, will have great practical interest.

With the view of obtaining data for a study of this subject, a circular was addressed to the several charcoal-iron furnaces of the country, and we are able to present in the following table the results as reported from twenty-three of these establishments. In the present state of this industry, many of these are now idle, and nothing could be reported from the experience of the last year. The returns, however, represent

---

[1] The process of manufacture is unknown as a practical art in Europe and America, but a brief description may lead to experiments, and perhaps to successful application:

The tree is cultivated with facility from cuttings, or by planting short pieces of root in the ground, so that one end just appears above the surface. It will sometimes grow a foot high the first year, and a yard the second. At about the third year it will be at the height of twelve feet. In the tenth month of each year they cut off the shoots close to the root, when several sprouts will appear, until they become a dense mass of shoots, which furnish the material for paper. They are cut into pieces some two feet long, and warmed in water till the bark can be easily peeled off by hand. It is then dried in the open air, immersed for twenty-four hours in running water, and beaten to separate the two kinds of fibers of which the bark is composed. The outside being of a dark color, is used for making paper of inferior quality, and the inner fibers for the finer sorts. The latter are made into masses of thirty pounds, washed in running water, and placed in tubs full of water, and after a time taken out and pressed by loading with stones. For artificial leather this substance is then treated with a lye made from the ashes of buckwheat bran, stirred for a time, again washed in running water till quite free from impurities, again beaten, and finally made into balls, and formed into shape for use. For paper they add an extract from the root of the *Hibiscus manihot*, and in summer some rice-water. It is then treated in the same manner as pulp in the manufacture of paper.

a wide area of country, and may doubtless be received as fairly representing the average experience of the country around them:

Summary of returns from charcoal furnaces and forges.

Number.	Name and location of furnaces or forges.	Bushels of charcoal used annually.	Bushels of charcoal used in making one ton of iron.	Cost of charcoal per bushel.	Mode of making charcoal.
				Cents.	
1	Woodstock Iron Company, Anniston, Calhoun County, Ala.	800,000	131	6½	Bee-hive kilns and coal-pits.
2	Center Furnace, Ky.	487,500	125	5	Open-air pits covered with earth.
3	Hunniwell Furnace, Ky.	(1875) 604,800 (1876) 691,800	150½ 142	6.89 6.27	Open-air pits covered with earth; it being impracticable to haul the wood to kilns.
4	Pennsylvania Furnace, Ky.	(1875) 294,400 (1876) 311,600	157 159	5.92 4.74	
5	Charlotte Furnace, Ky.	(1876) 540,600	206	4.52	
6	Menominee Iron Company, Mich.	1,000,000 to 1,300,000	130	4½ to 6	Conical kilns, of about 25 cords capacity.
7	Ozark Iron Works, Mo.	900,000	125	5¼	Open-air pits covered with earth.
8	Hamilton Iron Works, Mo.	500,000	140	4¼	Do.
9	Champlain Ore and Iron Company, Elizabethtown, Essex County, N. Y.	450,000	*280	8	Oblong kilns of brick; capacity, 60 cords.
10	Star Iron Works, Bowen & Signor Saranac, Clinton County, N. Y.; two forges, six fires each.	750,000 to 1,000,000	*280	6½	Kilns chiefly. Coal thus made is as good and much cleaner to work. This more than compensates for quality, if there is any difference, which we doubt.
11	Crown Point Iron Company, N. Y.	540,000	†300	8	Round kilns.
12	Wilmington Forge, N. Y.	200,000	†300	6	
13	Wassaic Furnace, Dutchess County, N. Y.	350,000 to 400,000	110 to 135	9 to 10	Kilns and pits.
14	Howard and Buckhorn Furnaces, Charcoal Iron Company, Ironton, Ohio.	960,000	150	6½	Coal-pits in the woods.
15	Mount Airy Forge, Shanesville, Berks County, Pa.	20,000	‡65	6	Coal-pits covered with leaves and dirt; work done by the job.
16	Eagle Furnace and Forge, Rowland, Centre County, Pa.	300,000	183	7	Coal-pits in the woods.
17	Carlisle Iron Works, Boiling Spring, Cumberland County, Pa.	....	§140	7	Coal-pits in the mountains.
18	Mainville Forge, Mainville, Columbia County, Pa.	70,000	†140	7	Coal-pits in old way.
19	Pottsdale Furnace, Tenn.	225,000	109½	6	Ordinary coal-pits.
20	Vernon Furnace, Tex.	480,000	160	6½	Coaling on hearths.
21	Barren Springs Furnace, Va.	126,000	115 to 125	5	In pits of about 35 cords.
22	Capon Iron Works, W. Va.	150,000	135	4	Pits in old way.
23	Richland Iron Company, Cazenovia, Wis.	750,000	....	6	Ordinary pits.

* For making one ton of slabs and blooms.
† Wrought iron.
‡ For one ton of blooms or billets.
§ Seventy-five to eighty for wrought iron.

Notes concerning kinds and qualities of wood used for making charcoal, yield, renewal, and management of woodlands.

[The numbers of these notes correspond with those in the first column of the preceding table.]

1. Pine and some hard woods used. Oak makes the best charcoal that we get. The yield is about 1,500 bushels to the acre, and 20,000 acres are sufficient for a permanent supply. Lands cut over are reserved for growing another crop, and the furnace now has 4,000 acres of young trees. When 8 years old they should be thinned out, getting 10 per cent. and leaving the rest in better condition for growing. Some attempts have been made at planting black walnuts around pasture-fields, but to no great extent. Charcoal burnt in open air better than in kilns, although the percentage of yield is less.

2. Oak and hickory regarded the best kinds of timber for making hard carboniferous coal. Gum and poplar make soft coal, of much less value. Charcoal made under soil

is cheapest and best. Have made some in brick ovens, but it was no better and much more expensive, on account of hauling wood instead of coal. The yield is about 1,400 bushels to the acre. About 10,440 acres would yield a permanent supply if no accident, such as fires, happened to the growing timber. Many furnaces in Kentucky have large tracts of woodland for growing new supplies. They are cut off once in 28 to 30 years.

3, 4, 5. Reported by the same agent. The kinds of timber used are black oak, chiefly; white oak, poplar, and pine in small quantities. Second-growth oak makes coal of best quality. About 1,400 bushels of coal are got from an acre. Probably 25,000 acres of timber would furnish a permanent supply for two furnaces of ordinary capacity, say 3,000 tons a year. Lands not specially reserved for another growth, the tendency being to clear and cultivate after cutting off first crop of timber. A second growth would be fit to cut in 20 years.

[The statistics of Savage Furnace, Kentucky, which may be taken as a representative instance in Eastern Kentucky, show a consumption of about 12,000 cords a year for an average blast of a little over 3,000 tons of iron. Allowing 30 to 35 cords of wood to the acre, this would give a decrease of forest area of 350 to 400 acres. From the best information obtained in this furnace region, it appears that from 23 to 25 years' growth is required to give an average of 30 to 35 cords, and that a tract of 9,000 to 10,000 acres is sufficient for the maintenance of a charcoal-furnace of this capacity with a perpetual supply.—(*A. R. Crandall:* Report on Forests of Greenup, Carter, Boyd, and Lawrence Counties, Ky., p. 22.)]

6. Pine wood and slabs, hemlock, tamarack, and black ash used for making charcoal. About 1,000 bushels, or 25 cords, are made from an acre.

7. Black, white, and post oak used for coal. Black oak is the best. An acre will yield about 1,000 bushels. From 40,000 to 50,000 acres would keep a furnace permanently supplied. Timber grows very slowly on uplands in this region (Phelps County, Kentucky), and cannot be cut for coaling before it is 50 years old.

8. Timber principally white and black oak, with some hickory, all making good hard coal for smelting purposes. About 700 bushels of coal are made per acre. The timber being small and of slow growth, 30,000 acres would probably be required to keep a furnace permanently supplied. More than half the land in this region is good for nothing except for growing timber. No second growth has been cut, and it would probably require 30 years for it to become large enough for profitable cutting.

9. Beech, maple, birch, and hemlock mostly used for charcoal. Hard woods are worth one-quarter more than soft. Both kinds are used mixed. An acre will yield 1,500 bushels, and 60,000 acres would supply the works permanently. About 30,000 acres are reserved, and a new growth may be cut in from 15 to 20 years.

10. Maple, beech, birch, hemlock, spruce, and other woods common to the country are used. Maple and birch deemed best, as far as economy in making is concerned, but when quality of iron is considered, a mixture of hard and soft wood coal is preferred. Their values are about as 10 to 8. Timber-lands yield about 2,500 bushels to the acre. They do not grow timber suitable for charcoal the second time, as they come up in wild cherry, and many years are required for other timber to work its way in. About 30 years would be required for a growth worth cutting.

11. Beech, birch, maple, poplar, spruce, and pine, yielding 1,000 bushels to the acre. A tract of 13,500 acres would furnish a permanent supply, and a new growth would be fit for coaling in 25 years.

12. Beech, birch, poplar, and spruce used, yielding from 1,000 to 1,500 bushels to the acre. Some lands, not fit for farming purposes, reserved for timber growth.

13. Chestnut, oak, hickory, birch, &c., used. The coal from these shows the same difference in quality as when the woods are burned in a stove. The first growth yields 35 to 40 cords per acre, the second growth 10 to 40. Two cords and a half make 100 bushels of coal. The wood for coaling is cut off at from 15 to 40 years of age.

14. The company has 14,400 acres of land, and produce all the materials of which our iron is made. Running lightly for last three years, but when in full blast use about 12,000 cords at each of two furnaces. All kinds of wood used, but chestnut or rock oak preferred. Yellow pine and poplar make the best yield. The gases utilized for making steam and heating the hot blast, but distilled products not saved. A cord will make 40 bushels, or about 1,600 bushels to the acre. Lands allowed to grow up again, which they readily do, and at 20 years of age will make a cord of wood to the acre annually, but at 15 years would not produce more than 10 cords. At 30 years can get 30 cords of better wood for coal than was obtained at the first cutting.

15. Maple, chestnut, oak, birch, and hickory. Second growth of maple, chestnut, and oak preferred to hickory, as the latter makes so much heat that it crumbles or breaks too fine. An acre yields 900 bushels. Being at the foot of the Blue Ridge, the broken land reserved for timber is large. When cut, it is allowed to sprout from the stump, and in 20 to 25 years is ready for cutting. Land that has been cleared would require nearly double the time for growing a crop fit for cutting.

16. Oak and white and yellow pine, with some maple and a little beech, get, on an

average, about 30 bushels from a cord. Woodlands may be cut over in 25 years, but are not specially reserved.

17. Chestnut, oak, and pine, yielding 500 to 600 bushels to the acre. The land will grow up for cutting again in from 30 to 35 years.

18. Use yellow pine and rock-oak, making very little difference. They yield about 900 bushels to the acre (30 cords at 30 bushels each). About 2,500 acres required to keep the works supplied permanently. Perhaps 5,000 acres reserved for wood growth. It is fit for cutting in 20 years, if not injured by mountain fires when young.

19. All kinds of oak, pine, chestnut, poplar, and beech used; the hard woods making the best coal. Land yields about 1,600 bushels to the acre. Forests abundant for supplies many years.

20. Oak, chestnut, hickory, and poplar used for charcoal. Great damage is done by fires running through young timber, and but little of the woodlands grow up again.

21. White and black oak, the latter being much the best. Average yield about 40 cords to the acre; yields 30 bushels to a cord. Timber is fit for a second cutting in 30 to 35 years. Timber abundant without seeding.

22. Chestnut-oak, pine, white oak, chestnut, hickory, maple, &c., used for coal, and about 1,500 bushels got from an acre; 5,000 to 6,000 acres might supply a furnace, the new growth being cut once in about 20 years.

23. Red and white oak and a little maple. No bass or white woods used. This is a new enterprise, and cannot state results of experience.

A statistical summary of iron manufacture at charcoal-furnaces in New England and New York, prepared by William G. Neilson, for the American Iron and Steel Association, shows the following result at charcoal blast furnaces in 1864:

New England: 16 furnaces used 71,569 tons of ore and 3,747,489 bushels of charcoal, and made 28,909 tons of iron; average, 52½ bushels to a ton of ore, or about 129 bushels to a ton of iron.

New York: 16 furnaces used 44,635 tons of ore and 2,911,832 bushels of charcoal, and made 20,218 tons of iron; average, 65¼ bushels to a ton of ore, or a little over 144 bushels to a ton of iron.

It will be seen from the foregoing, that while differences of opinion are expressed with reference to the mode of manufacture, much the greatest number prefer charcoal made in a coal-pit (called by the French *meule*, and by the Germans *meiler*), and that scarcely a thought has been had as to the saving of the volatile products of carbonization. The chief argument in favor of making charcoal in the woods, is the economy in transportation, it being cheaper to bring it than cordwood from the forests, especially from distant points and over broken ground.

It may not be improper in this connection to notice some facts in the production of charcoal that may have practical application.

The timber should be well seasoned. Coniferous wood will dry soonest if left after felling with branches on, until the needles dry up and fall off, as they appear to evaporate moisture for a time. The peeling off of strips of the bark hastens the process of seasoning, and splitting still more so. Trees felled toward the north expose the butts to the sun, and this hastens drying. Timber cut during the suspension of active vegetation makes better charcoal and more of it than when cut in the growing season. Floated wood does not make coal of as good quality as that which has not been soaked in water. Wood that has lain too long in the woods, so as to begin to decay, makes poor charcoal. The hearth should be perfectly dry, solid, level, and free from draught,[1] and is found to improve by use, making it an object to continue it where possible, in preference to making a new one. They are sometimes made of stone or tiles, covered with a mixture of sand and clay, packed hard. The best season for coaling is the end of summer or early in autumn, the wood having been cut the winter previous and piled for drying through the summer. The expense of watching a small *meiler* is about

[1] In a loose, gravelly soil the air might be drawn in at the bottom, beyond the control of those in charge, and to the great injury of the result.

the same as of a large one, but, as in case of accident the loss might be greater, it is thought safer to have them of moderate size. One collier can watch two *standing meilers* (where the wood is placed upright) or three *lying meilers* (the wood laid horizontally) at the same time.

The yield of charcoal varies, but is usually 30 to 40 per cent. of volume of the wood,[1] and from 18 to 22 per cent. of the weight—seldom over 25 per cent. by the ordinary methods, where the wood has been exposed two or three months in the open air after cutting. Well-made charcoal retains the form and structure of the wood, is brittle, and somewhat cracked, and very sonorous. When buried in the earth it is nearly indestructible, and for this reason is sometimes used in fixing the corners in land-surveys. They say that charcoal has been "too much cooked" if it loses its sonorous quality, and is too much cracked. If not done enough it is not black, nor is the fracture bright.

As a rule, the heating power of charcoal from different kinds of wood bears about the same proportion to one another as did the woods themselves, and with like degree of dryness is in proportion to density. In a given kind of timber it may vary greatly, according to climate, location, exposure, soil, age, and the season when cut, as well as the part of the tree from which taken. The branches have less heating power than the trunks in deciduous trees, but the reverse of this in the conifers. Woods that dry slowly generally burn slowly, because, being compact, the pores do not admit the air necessary for combustion, and their charcoal lasts longer, but gives less heat. Wood that has laid some months, and contains only 20 to 25 per cent. of hygrometrical water, makes better coal than that burnt *green* or *very dry*. Light porous woods and their charcoal burn briskly, and often contain gases which cause a crackling when burning. Charcoal used in making gunpowder is from light soft woods, such as willow, alder, mountain ash, birch, hazel, &c., and great care must be taken to prevent the introduction of sand. The woods are peeled, and are burned in iron retorts, the heat being externally applied.

Kilns or ovens for reducing wood to charcoal are generally made of brick, and are of two kinds, the conical and the rectangular. The usual size of the conical kiln is 24 feet in diameter, with a little greater height, holding about forty cords of wood. They should be lined with fire-brick to a height of 10 or 12 feet from the bottom, and are often plastered both outside and inside. A band of heavy strap-iron should be placed around the middle, and they are furnished with doors of boiler-plate iron, and drawn together with screw-bolts. The top is closed by a circular plate of iron that may be raised when necessary. Air-holes are made around the bottom, which may be closed by loose bricks. The joints around the doors and any cracks that may appear in the wall are to be closed with clay or plaster.

The rectangular form is usually 40 feet long, 16 feet wide, and 15 feet high on the outside, with a timber framework. The walls should be a foot thick; the top is arched, and air-holes are provided as in the other form. Such a kiln will hold about eighty cords of wood, and will burn over 3,000 bushels at a time. The yield by either of these kilns with hard wood will range from 42 to 45 bushels to the cord. The large kind can be filled, burned, and emptied in about four weeks, and the smaller

[1] In Sweden the yield is about 63.2 per cent. of volume, with the *Pinus picea* and *Abies excelsa*. Where the wood is set vertically, it is about 5 to 8 per cent. less than where it is horizontal. In Upper Silesia it is 52.6 per cent. for the stem, 42.7 for the branches, and 39.5 for the roots.—*Percy*.

kind once in three weeks, which is about the time commonly taken to burn a coal-pit.[1]

From experiments made by Marcus Bull, about fifty years ago[2], dead wood was found to produce the same quantity of charcoal as the same cut in a living state, and the limbs of trees made coal of greater density than the trunk. Stove-dried ebony (specific gravity 1.090) gave 33.82 per cent. of charcoal, a greater average than any other kind tried, and its specific gravity was also greater, being .888. Its fracture much resembled that of some mineral coals. Stove-dried live-oak (specific gravity .942) gave 32.43 (specific gravity .591); tortoise-shell wood (sepecific gravity 1.212) gave 30.31 (specific gravity .866); cocoa (specific gravity 1.231) gave 28.53 (specific gravity .742), and Turkey box-wood (specific gravity .933) gave 27.24 (specific gravity .622).

We draw the conclusion that the density and durability of charcoal from different woods are not due to the amount of carbon that they contain. The percentage, specific gravity, and weight of charcoal from a great variety of American timber-trees are given in the table of Mr. Bull, upon a subsequent page of this report.

The percentage of charcoal in the same wood varies according to its age and the manner in which it has been prepared, whether quickly or slowly. The following results obtained by Karsten, modified in part by the experiments of M. Violette, will illustrate this point.

Percentage of charcoal of young and old Timber burned slowly or rapidly.

	Rapidly.	Slowly.		Rapidly.	Slowly.
Oak, young	16.54	25.60	Silver fir, old	14.05	25.00
old	15.91	25.71	Alder, young	14.45	25.65
Beech, young	14.87	25.87	old	15.30	25.65
old	14.15	26.15	False-fir, young	16.22	27.72
Hornbeam, young	13.12	25.22	old	15.35	24.75
old	13.65	26.45	Pine, young	15.52	26.07
Birch, young	13.05	25.05	old	13.75	25.95
old	12.20	24.70	Basswood	13.33	24.50
Silver fir, young	14.25	25.25			

[1] In September, 1862, the Swedish Government offered a prize of 1,500 rix-dollars for a popular treatise on the manufacture of charcoal and the preparation of peat. In March, 1864, four treatises had been offered, but none were accepted. In June, 1867, seven were presented, but neither received the prize, but the committee decided to give the authors of the two best 850 rix-dollars, upon condition of being allowed to use them. These were placed in the hands of Mr. G. Svedelius, who was designated to prepare a work on charcoal-making, availing himself of whatever information he might be able to get. His book is entitled "*Om Kolning i Mila;*" and it was published in 1872. A translation by Prof. R. B. Anderson, of the University of Wisconsin, with notes by Prof. W. J. L. Nicodemus, of the same institution, was published in New York, in 1875, under the title of "*Hand-Book for Charcoal-Burners.*" It relates chiefly to the construction and burning of *meilers* or coal-pits.

The reader is also referred to the following:

Art du Charbonnier. By Du Hamel du Monceau, Paris, 1761.

Memoire sur un Nouvelle appareil pour le carbonisation des Bois en forêt. By E. Dromart, Paris, 1868.

Carbonisation du Bois et emploi du combustible dans la metallurgie du Fer. By A. Gillot, Paris, pp. 390.

Carbonisation des Bois en vases clos et utilisation des products dérivés. By Camille Vincent, Paris, 1873.

On the making of charcoal. Journal Franklin Institute (1831), vii, 71.

Percy's Metallurgy. (1875.) Pp. 366–414.

Karsten's System der Metallurgie. Vol. iii.

The works of Charles David Von Uhr, Thomas Scheever, C. A. Smith, G. A. Molinder, and Ferdinand Von Klein, also contain valuable information upon this subject.

[2] *Experiments to determine the comparative value of the principal varieties of fuel, &c.,* page 59.

The quantity of carbon in charcoal depends upon the temperature, the duration of the process, and the kind of wood. According to the experiments of Violette, 100 parts of buckthorn wood gave: At 250° (C.), 50 parts of charcoal; at 300°, 33; at 400°, 20; and at a white heat (about 1,800° C.), but 15 parts, the times in each case being alike. Then the duration varies; in working at the same temperature the amount of charcoal is proportioned to the time employed, more volatile parts escaping in some cases than in others. The composition of charcoal varies with the temperature at which made: thus, at 250°, the carbon forms 65 per cent.; at 300° it is 73 per cent.; at 400° it is 80 per cent.; and at about 1,500° it is 96 per cent.

Woods of compact grain carbonize more slowly, and yield a coal of greater density and greater quantity. The following results were obtained in woods dried at 150° and carbonized at 300°:

Elm, 46.99; guaiacum, 41.86; box, 40.44; ash, 38.28; oak, 34.60; hornbeam, 34.44; birch, 34.17; maple, 33.75; buckthorn, 33.61; cornel, 33.36.

The variable composition of different woods, charred at the same degree of heat, is given by percentages in the following table from Vincent:

Woods.	Carbon.	Hydrogen.	Oxygen and nitrogen.	Ashes.
Buckthorn	73.236	4.254	21.962	0.569
Birch	71.133	4.552	23.554	0.760
Box	70.499	3.740	24.115	0.643
Ash	70.395	4.539	24.367	0.692
Maple	70.069	4.613	24.892	0.425
Cornel	69.026	3.840	26.490	0.634
Hornbeam	68.835	4.142	26.382	0.641
Poplar	68.741	4.866	25.539	0.853
Holly	68.521	4.741	25.870	0.847
Aspen	68.169	5.512	25.729	0.589
Oak	67.421	4.099	28.479	0.200
Elm	66.862	4.669	28.181	0.288

Charcoal exposed to the air, absorbs moisture in variable quantity according to the temperature at which it was burned. Thus, at 150° it absorbs 21 per cent. of its weight; at 250°, 7 per cent.; at 350°, 6 per cent.; at 450°, 4 per cent.; and at about 1,500°, about 2 per cent. The rule, then, is, that the higher the temperature the less the absorption.

The charcoal from high degrees of heat is a better conductor of electricity. This property is very feeble in coals obtained at 150° to 300°, but at 1,500° it is two-thirds as great as iron. The carbon from gas-retorts is used for the positive poles of circuits, and for the pencils used in generating electrical lights.

The kindling temperature in the open air is higher where the heat has been greater. Thus, coals burned at 260° to 280° take fire at 340° to 360°; those burned at 290° to 350° take fire at 360° to 370°; those at 400° kindle at 400°; and those at 1,000° to 1,500°, at 600° to 800°; and these latter burn with difficulty.

Charcoals once kindled burn for a time that decreases according as the temperature of carbonization has been greater—those of lower degree lasting longer. When freshly drawn from the kiln or *meiler*, and after complete cooling, charcoal is liable to spontaneous combustion at common temperatures, from the property it has of condensing the gases in its pores. It is obviated by lightly sprinkling, so as to supply the moisture it would take in from the air.

Charcoal will absorb coloring matter, forming insoluble compounds with many inorganic bodies. It is probable that the bodies absorbed contract a kind of adhesion upon the surface, in the manner of mordants in fixing the colors in tissues. The organic matters absorbed cannot be separated without modifications; wood-charcoal absorbs gases without combining with them. The volume is variable according to the nature of the gas, those most soluble in water being most absorbed by the charcoal. The volumes of different gases absorbed are stated as follows: for one of charcoal, viz, ammonia, 90; hydrochloric acid, 85; sulphuric acid, 65; hydro-sulphuric acid, 55; protoxide of nitrogen, 40; carbonic acid, 35; bicarbonated hydrogen, 35; oxide of carbon, 9.42; oxygen, 9.25; nitrogen, 7.5; hydrogen, 1.75. Gases absorbed by charcoal are given out in a vacuum. Damp charcoal loses in a great degree its property of absorbing gases.

In the industries this absorbing power of charcoal is employed in disinfecting certain places where noxious gases abound, and in purifying liquids. Muddy waters filtered through charcoal placed in layers between sand will be rendered pure and potable, and may be preserved a long time. The inside of water-casks in ships, if charred, will keep the waters sweet for a long time.

Charcoals made from certain vegetable substances are employed as coloring substances, such as Spanish black from cork, peach-black from peach-stones, and lamp-black from resinous woods and the resins.

The Chinese have a method of charring wood in pits and arched chambers in the ground, and carry the process to great perfection.[1]

The Moreau process.—Attention has been drawn in France within a few years to a process of carbonization invented by Jules Moreau, by which it is claimed a saving is made in the amount and quality of the charcoal, and still further in the condensation of volatile products, by which the offensive odors of coal-making are avoided, and profitable materials besides charcoal are obtained.

This apparatus consists of a cylinder of thick sheet-iron, of a size that can be easily carried by two men, about two meters high, and of the same diameter. It will hold about six cubic meters of wood and has at the upper end a manhole for filling with wood, and a pipe through which the fire is introduced in kindling and the smoke may escape. At the lower part are six registers through which the air is admitted into a circular tube pierced with holes on the under side, so that the air is sifted, as it were, in entering the vessel. The apparatus sets on the ground, and has no bottom, so that when the operation is finished it can be turned over on its side and the charcoal is at once obtained. The yield is claimed to be from 41 to 43 per cent. in value, and 30 per cent. in weight, a hectoliter of such coal weighing 23 to 25 kilograms. It is also used for carbonizing peat. The quality of the coal may be varied, and wood may be torrified for use in high furnaces, the yield in this case being 75 per cent. volume. Three workmen can tend ten pieces of this apparatus, each yielding 25 hectoliters of charcoal.[2]

The Dromart process.—This consists in carbonizing wood in an apparatus made of iron, which may be taken apart in sections and put up in a new place, as occasion may require. It allows the process of carbonization to be regulated so that it may be done rapidly or slowly, and, as

---

[1] See *Percy's Metallurgy* (1875), p. 384, where figures are given of the constructions used. The *Annuaire du Jour. des Mines de Russie*, 1838, p. 375, gives an article, by M. Kovanko, describing the Chinese methods.

[2] *Revue des Eaux et Forêts*, vi, 94; viii, 416; xi, 366.

is claimed, with great uniformity of result. It consists of a floor composed of 48 iron plates resting in a frame-work of iron upon the ground, properly prepared by packing solid clay, or by masonry, so as to afford a level circular area with a groove around the edge for receiving the iron plates of the side. A series of 16 plates of iron is arranged in a circle, and above these two other tiers still above, forming a dome-shaped kiln or oven, held together by iron bands and bolts, with an iron chimney at the top, and eight smaller chimneys around the sides, communicating with openings in the base. A large door is provided below, and a smaller one above, for filling with wood and for withdrawing the charcoal. By a ladder and platform the workmen can reach the chimney at the top for regulating the draught. The whole, when in use, is luted with clay so as to be air-tight, except as air is admitted at will. Below the iron floor is a flue with a fire-place opening externally. It should be made of hard-burned bricks, and the fire-place may be large for burning brush and other waste wood. This serves for kindling the kiln and for assisting the process. The wood is piled vertically excepting toward the top. The usual charge is 50 stères (about 14 cords), but it may be raised to 70 where the ground is dry. The heaviest piece does not weigh over 50 kilograms (110 pounds), so that it may be carried to any place in the woods. The whole weight for a 50-stère kiln is 4,500 kilograms (9,920.7 pounds), and one for 20 stères, 1,800 kilograms (3,968 pounds). For the former the base is $5^{m}.2$ ($19\frac{2}{3}$ feet) across. The removal and putting up depends, of course, upon local circumstances; the costs, at a minimum, 180 francs. It is commonly moved about twice a year.

The time required for burning varies from 48 to 56 hours. It is claimed that the apparatus will last ten years in common use, except that the lower side plates and doors may need renewal.[1]

Red charcoal—Torrefied wood.

About 1836, a method was introduced in France for the semi-carbonization of wood, by placing it in chambers built at the mouths of furnaces and exposed to a heat by which the water and acetic acid were expelled but the combustible gases left, which would contribute to the heating properties of the coal thus partly produced, and a considerable saving of fuel gained. This product is known as "red charcoal," and for certain metallurgical processes, such as melting cast iron, it is said about thirty per cent. is saved in the cost of fuel over the amount required with charcoal fully carbonized.

Torrefied wood is wood that has been heated enough to drive off the hygroscopic water, and just to a point where carbonization begins. In beech, this product resembles the wood itself, except in color. It may be split, cut, or sawed, but is not so strong as the original wood. It ignites easily, does not impair by keeping, and burns with a copious flame and with intense heat. It is understood that some of the charcoal furnaces in the Lake Superior region use wood not fully charred with good results, but we have no precise account of their methods.[2]

---

[1] *Ann. des Mines*, s. 3, 1837, xi, p. 527, and s. 3, 1838, xiii, 487, 595, contain articles by Sauvage upon this method. See, also, an article on "The Economy effected by the Use of Red-Charcoal," by Bernard Frenow, in the *Engineering and Mining Journal*, N. Y., March 2, 1878.

[2] R. Fresenius, in *Erdmann's Jour. für Praktisch Chemie*, 1868, ciii, 88. In 1839, Echement, a Belgian, made brown charcoal in piles. See *Ann. des Mines*, s. 3, xvi, 654, and *Percy's Metallurgy* (1875), p. 410, where a description of the process is given.

ILLUMINATING GAS FROM WOOD.

Gas is now made of great excellence from wood, and in countries where the price of coal suitable for gas-works has raised above the point at which it could be used with profit, experiments have been going on for years, in the hope of finding an economical substitute. Wood, peat, the dregs of grapes, and other substances have been tried. The first results with wood proved so unsatisfactory, that it was for a time abandoned, as gas obtained at a low heat has but moderate illuminating power.[1]

In 1869, Pettenkofer, of Munich, in experimenting upon the carbonization of wood, observed that the gas obtained at low temperatures was not rich in the hydrocarbons, but that when raised to a cherry-red heat, the gases disengaged by the reaction of the elements were, when purified, much superior in illuminating power to the best obtained from coal. With this discovery Riedinger has been able to establish the manufacture of wood-gas as a profitable industry.

The kind of wood used for gas appears to have but little influence upon the yield, as is shown by the following table:

Cubic meters of purified Gas obtained from 100 *kilograms of Wood.*[2]

Pine	33,840	Larch	33,000
Fir	38,880	Willow	39,600
Poplar	35,440	Oak	34,020
Bass-wood	39,800	Beech	33,450

The hygrometrical condition, however, has much influence, as well upon the quality as the quantity of the gas-product; in fact, we notice that if a part of the wood be already carbonized, the portion not decomposed will disengage the vapor of water, which, passing over the incandescent carbon, will form much oxide of carbon and of hydrogen, which will proportionally reduce the illuminating power of the gas. From the above it will be inferred that in making gas from wood, we should select the kinds that commercially offer the greatest advantage, without being particular as to the kind; and, furthermore, that it should be dried as much as possible before using, and be used as soon after drying as may be, because it will rapidly regain by absorption from the air much of the moisture it has lost.[3]

---

[1] The first person who attempted to submit wood to distillation for the purpose of obtaining gas and other products, was Philip Lebon, near the close of the last century; and in the year VIII (1799) he took out a French patent for new methods of using combustibles with greater economy, as well for heat as for light, and for collecting the different products. Three years after, he obtained the use of a part of the Rouvray forest, near Havre, for the manufacture of tar, engaging to deliver five quintals a day, and with apparatus of large dimensions he was able to supply a notable quantity of tar for the marine. He died in Paris in December, 1804, and the business was continued under his widow's direction till 1811.

[2] By dividing these quantities by 16 we shall have very nearly the cubic feet of gas from one pound of wood.

[3] In practice, they use for this purpose the heat lost in the distilling-ovens, by building behind them a room in masonry, which becomes a true stove, the floor being made of cast-iron plates, under which the products of combustion pass from the ovens to the chimney. The wood is piled in this room and left about twenty-four hours. It is then taken out, to be placed from time to time, as occasion requires, in the retorts of the gas-works.

The retorts for making wood-gas should be so arranged that the volatile products should be subjected for a certain time to a high temperature. The first ones employed were divided by partitions, and the disengaged products passed into the exterior compartments, the wood being placed in the middle. But this form of apparatus was found so inconvenient in practice, that they were obliged to abandon its use. Riedinger attempted to use the common gas-retorts, making them considerably larger than the charge of wood, and obtained very good results, which has led to the general use of retorts of this kind. The wood gives off very rapidly a large amount of gaseous prod-

Other distilled products of wood.—Referring to special treatises, and especially to Vincent's above quoted, for a particular account of methods, we can here only enumerate some of the principal liquid and crystalline products to be obtained from woods, chiefly from the oak, beech, hornbeam, and other hard woods—not earlier than 20 years of age, and cut in the winter-time.

---

ucts, which causes a considerable cooling of the retorts, and therefore it becomes necessary to apply a large amount of heat within a very short time. The material of which the retorts are made should therefore have a greater power of conducting heat than those used with coal. It is therefore best that they should be made of cast iron.

The form of the retorts is generally the same as that for coal. The charge being 50 kilograms (110¼ pounds) of dry wood, they should be 11.8 to 13.8 inches high, 22 to 23⅓ inches wide, and 102⅓ to 106¼ inches long. For a charge of 75 kilograms (165⅓ pounds), we use retorts 17¾ inches high, 25.6 inches wide, and 106¼ inches long.

A retort of the first of these sizes will yield from 200 to 240 meters (7,063 to 8,475 cubic feet) in 24 hours, while one of the second size should give 250 to 300 meters (8,829 to 10,594 cubic feet) in the same time.

From what has been said it will be inferred that the furnaces should be like those employed for coal, but with a larger amount of grate-surface. In regular working order, an operation lasts an hour and a half, and about one-half of the whole volume of gas is disengaged during the first half-hour of the distillation. When the operation is done, the retorts are opened, and the charcoal is drawn out into sheet-iron extinguishers, which are at once closed and luted, and then left to cool.

As the gases come out of the retorts, they pass into a cask-shaped vessel, and then to the cooling apparatus; but because of the very rapid distillation of the wood these parts of the apparatus should have a very considerable diameter, and should be cooled more energetically than those used in making coal-gas. They generally give a shaped form to the section of the cask, to facilitate the joining of the plunging-pipes coming from the retorts, and place it in a sheet-iron vat that is cooled by a stream of cold water. Moreover, as the products are strongly corrosive from the acetic acid, it is well to make the cooling apparatus of copper, because sheet iron, or even cast iron, would be otherwise rapidly consumed. In the receiving-cask the tar and pyroligneous acid are condensed, and flow out in a steady stream. The gas on coming out of this receiver passes into coolers and washers analogous to those used for coal-gas, and then into pits of lime-purifiers.

Wood-gas contains a quantity of carbonic-acid gas, varying from a quarter to a fifth part of the whole volume, from which it will be inferred that the hydrated alkalies are the only agents that can be advantageously employed for the rapid purification of such a mixture. They therefore pass the gas through purifiers charged with quicklime, mixed with light substances for dividing it, such as tan-bark, mosses, or sawdust, placed in layers two or three inches thick, taking care to make the gas pass up evenly through the layers of half lime. In practice, they use 100 to 110 kilograms (220½ to 242½ pounds) of lime for purifying 100 cubic meters (3,531 cubic feet) of gas, with 10 square meters (107.6 square feet) of the loose materials, and still there will often remain from one to two per cent. of carbonic-acid gas in the purified gas. The lime absorbs, besides carbonic-acid gas, some of the acetic acid which has escaped condensation, and some of the phenols, which are, however, but imperfectly absorbed. The enormous amonnt of lime needed in purifying wood-gas is a great inconvenience in this manufacture.

The following table shows by percentages the composition of gas from different kinds of wood after purification:

Kind of wood.	Oxide of carbon.	Hydrogen.	Marsh-gas.	Heavy hydro-carbon.
Poplar	25.62	31.84	35.30	7.24
Bass-wood	22.30	48.67	21.17	7.86
Larch	40.28	29.76	20.96	9.00
Willow	39.04	29.60	24.02	7.34

We see from this, that wood-gas, like coal-gas, is a mixture of the oxide of carbon, hydrogen, marsh-gas, and the heavy hydro-carbons which render it illuminating. Among the latter we may mention acetylene, olefient gas, propylene, benzine, toluene, xylene, &c. The production of the heavy carburets takes place especially at the beginning of the distillation, and goes on diminishing very rapidly, so that the gas, toward the end of the process, has very little illuminating power. According to Liebeg's experiments, the light of wood-gas is to that from coal as 6 is to 5.

The density of wood-gas is quite considerable, and varies between 0.6 and 0.7, which is chiefly due to the large proportion of the oxide of carbon which it contains. But

When wood is submitted to distillation in close vessels, the volatile products, beside gases, vary according to the nature of the wood, the temperature, and the time employed in the process. There come over the vapor of water, mingled with acetic acid, methylic alcohol, acetate of methyl, acetone, creosote, phenols, and tar-like substances of complex composition, and of relatively small amount.[1]

---

with a given orifice, and under equal pressure, the amount of gas passing out will be in proportion to the square root of the density. Moreover, to burn the oxide of carbon, which forms so large a proportion in wood-gas, we need much less air than in burning a gas rich in protocarbonated hydrogen. The air will penetrate more rapidly a jet of wood-gas than a similar one of coal-gas, and if we do not increase the thickness of the jet of gas, the relative excess of air will reduce the illuminating power to a point that will, so to speak, annul it. We see, therefore, that burners that operate well with coal-gas would not serve the purpose with wood-gas, and *vice versa*, under a pressure of 2 to 3 millimeters of water (about $\frac{1}{12}$ to $\frac{1}{8}$ of an inch), the bat-wing tips, having a width of about $0^{mm}.9$ (0.0394 inch.) gives the best results with wood-gas.

The secondary products in the making of wood-gas are tar-water and charcoal. The former of these, condensed in the receiving-cask and in the refrigerators beyond, are left to stand in wooden tanks to allow the tar to separate from the acid waters, and the latter are then saturated with quicklime, so as to form the pyrolignite of lime by processes above indicated, which reduces quite considerably the cost of making gas. From one hundred parts of wood they get fifty to seventy-five of the crude acetate of lime, dry. The tar when separated will serve to mix with coal-dust, or may be used directly for painting. They represent about 2 per cent. in weight of the dry wood used. The charcoal is very light when carbonized quickly from tender woods, and burns easily and rapidly. It serves very well for domestic use, and is sure to find a ready sale in cities.

The advantages of wood-gas are as follows: It is completely free from sulphurous fumes, which do so much injury to paints having lead as their base, as often happens with coal-gas when imperfectly purified, and in burning it gives out no sulphurous acid. A given weight of wood will furnish more gas than a like weight of coal, and more rapidly. It follows that for a given production, a considerable less amount of apparatus is needed, and less space than for coal-gas. The making of wood-gas is more profitable than from coal wherever pine or fir wood (not floated) costs less than coal-gas; but we must always take into account the lime needed in purifying, which is sometimes difficult to obtain at a low price in certain localities.

But we may use wood of inferior quality and of all sizes, and in very many localities it will be found that the cost is altogether in favor of wood-gas.—(*Carbonisation des Bois en vases clos, et utilisation des produits dérivés.* By Camille Vincent. Paris, 1873, p. 145.)

[1] The liquid products passing over and condensed in a wooden cask, separate into three distinct strata: the lower of tar and the heavy creosote oils, saturated with acetic acid; the middle, of water, pyroligneous acid, wood spirits, acetone, and the tarry compounds having affinity with acetic acid, and wood spirits, methyl-acetic ether, and oxyphenic acid; and the upper layer, of the light and tarry oils, holding acetic acid in solution. These are drawn off by faucets placed at different levels, and by separate treatment, which we cannot here detail, finally yield the following products:

Acetic acid, of various grades, for use in the arts, and for table use, and the varied acetates used in coloring and otherwise, as the acetates of soda, potash, ammonia, barytes, lime, manganese, alumina, magnesia, iron, chromium, zinc, nickel, cobalt, lead, mercury, silver, bismuth, antimony, uranium, and copper, with various neutral, sesquibasic, bibasic, and tribasic acetates, and other combinations in great variety.

Pyrolignites of lime, iron, and lead: methylic alcohol, and others, with combinations of oxygen, chlorine, bromine, iodine, fluorine, cyanogen, sulphur, nitrogen, boron, &c., and a large and constantly increasing number of products, many of them of known use, and others of only scientific interest, result from the chemical processes applied to these liquid products of distillation of wood. Their principal use is in furnishing antiseptic materials for increasing the durability of timber and other organic materials, and in supplying mordants and dyes for coloring.

There are two classes of distilling apparatus. In one, the external air is admitted, as in the *meiler* and *kiln*, where carbonization is effected at the expense of a part of the wood carbonized; and in the other, the retorts are wholly closed and heat is applied entirely from without. The latter are subdivided into fixed and movable apparatus, the latter implying cranes and other machinery for lifting and placing the receivers and their contents.

The best results, where all products are saved and all precautions are adopted, give charcoal 26 parts, pyroligneous acid and water 30 parts, tar 7 parts, carbonic acid and oxide, hydro-carbon and vapor of water not condensed, 37 parts. The weight of wood added as fuel to effect this distillation, is about 12½ parts.

COMPARATIVE VALUE OF WOODS FOR FUEL.—EXPERIMENTS BY MARCUS BULL.

A paper read before the American Philosophical Society, April 7, 1826, by Marcus Bull, of Philadelphia,[1] gives the results of careful experiments upon qualities and relative values of American woods, that have been regarded as trustworthy and valuable. In conducting these experiments, Mr. Bull constructed a room within a room,[2] so that the walls of the inner one could be kept uniform in temperature, and combustion was made in a stove with an abundance of pipe. The time and effects were carefully noted, and all circumstances affecting draught of air, size and condition of fuel, &c., were made as uniform as possible.

Common and botanical names.*	Specific gravity of dry wood.	Avoirdupois pounds of dry wood in one cord.	Product of charcoal from 100 parts of dry wood, by weight.	Specific gravities of dry coal.	Pounds of dry coal in one bushel.	Pounds of charcoal from one cord of dry wood.	Bushels of charcoal from one cord of dry wood.	Time 10° of heat were maintained in the room by the combustion of one pound of each article.		Value of specified quantities of each article compared with shell-bark hickory as the standard.
								h.	m.	
White ash (*Fraxinus americana*)	.772	3450	25.74	.547	28.78	888	31	6	40	77
Apple tree (*Pyrus malus*)	.697	3115	25.	.445	23.41	779	33	6	40	70
White beech (*Fagus sylvestris*)	.724	3236	19.62	.518	27.26	635	23	6		65
Black birch (*Betula lenta*)	.697	3115	19.40	.428	22.52	604	27	6		63
White birch (*Betula populifolia*)	.530	2369	19	.364	19.15	450	24	6		48
Butter-nut (*Juglans cathartica*)	.567	2534	20.79	.237	12.47	527	42	6		51
Red cedar (*Juniperus virginiana*)	.565	2525	24.72	.238	12.52	624	50	6	40	56
American chestnut (*Castanea vesca*)	.522	2333	25.29	.379	19.94	590	30	6	40	52
Wild cherry (*Cerasus virginiana*)	.597	2668	21.70	.411	21.63	579	27	6	10	55
Dogwood (*Cornus florida*)	.815	3643	21	.550	28.94	765	26	6	10	75
White elm (*Ulmus americana*)	.580	2592	24.85	.357	18.79	644	34	6	40	58
Sour gum (*Nyssa sylvatica*)	.703	3142	22.16	.400	21.05	696	33	6	20	67
Sweet gum (*Liquidambar styraciflua*)	.634	2834	19.69	.413	21.73	558	26	6		57
Shell-bark hickory (*Juglans squamosa*)	1.000	4469	26.22	.625	32.89	1172	36	6	40	100
Pig-nut hickory (*Juglans porcina*)	.949	4241	25.22	.637	33.52	1070	32	6	40	95
Red-heart hickory (*Juglans laciniata?*)	.829	3705	22.90	.509	26.78	848	32	6	30	81
Witch-hazel (*Hamamelis virginica*)	.784	3505	21.40	.368	19.36	750	39	6	10	72
American holly (*Ilex opaca*)	.602	2691	22.77	.374	19.68	613	31	6	20	57
American hornbeam (*Carpinus americana*)	.720	3218	19	.455	23.94	611	25	6		65
Mountain laurel (*Kalmia latifolia*)	.663	2963	24.02	.457	24.05	712	30	6	40	66
Hard maple (*Acer saccharinum*)	.644	2878	21.43	.431	22.68	617	27	6	10	60
Soft maple (*Acer rubrum*)	.597	2668	20.64	.370	19.47	551	28	6		54
Large magnolia (*Magnolia grandiflora*)	.605	2704	21.59	.406	21.36	584	27	6	10	56
Chestnut white oak (*Quercus prinus palustris*)	.885	3955	22.76	.481	25.31	900	36	6	30	86
White oak (*Quercus alba*)	.855	3821	21.62	.401	21.10	826	39	6	20	81
Shell-bark white oak (*Quercus obtusiloba?*)	.775	3464	21.50	.437	22.99	745	32	6	20	74
Barren scrub oak (*Quercus catesbœi*)	.747	3339	23.17	.392	20.63	774	38	6	30	73
Pin oak (*Quercus palustris*)	747	3339	22.22	.436	22.94	742	32	6	20	71
Scrub black oak (*Quercus Banisteri*)	728	3254	23.80	.387	20.36	774	38	6	30	71
Red oak (*Quercus rubra*)	.728	3254	22.43	.400	21.05	630	30	6	20	69
Barren oak (*Quercus ferruginea*)	.694	3102	22.37	.447	23.52	694	29	6	20	66
Rock chestnut oak (*Quercus prinus monticola*)	.678	3030	20.86	.436	22.94	632	28	6		61
Yellow oak (*Quercus prinus acuminata*)	.653	2919	21.60	.295	15.52	631	41	6	10	60
Spanish oak (*Quercus falcata*)	.548	2449	22.95	.362	19.05	562	30	6	20	52
Persimmon (*Diospyros virginiana*)	.711	3178	23.44	.469	24.68	745	30	6	30	69
Yellow pine (soft) (*Pinus mitis*)	.551	2463	23.75	.333	17.52	585	33	6	30	54
Jersey pine (*Pinus inops*)	.478	2137	24.88	.385	20.26	532	26	6	40	48
Pitch pine (*Pinus rigida*)	.426	1904	26.76	.298	15.68	510	33	6	40	43
White pine (*Pinus strobus*)	.418	1868	24.35	.293	15.42	455	30	6	40	42
Yellow poplar (*Lyriodendron tulipifera*)	.563	2516	21.81	.383	20.15	549	27	6	10	52
Lombardy poplar (*Populus dilatata*)	.397	1774	25	.245	12.89	444	34	6	40	40
Sassafras (*Laurus sassafras*)	.618	2762	22.58	.427	22.47	624	28	6	20	59
Wild service (*Aronia arborea*)	.887	3964	22.62	.594	31.26	897	29	6	20	84
Sycamore (*Acer pseudo-platanus*)	.535	2391	23.60	.374	19.68	564	29	6	30	52
Black walnut (*Juglans nigra*)	.681	3044	22.56	.418	22	687	31	6	20	65
Swamp whortleberry (*Vaccinium corymbosum*)	.752	3361	23.30	.505	26.57	783	29	6	30	73

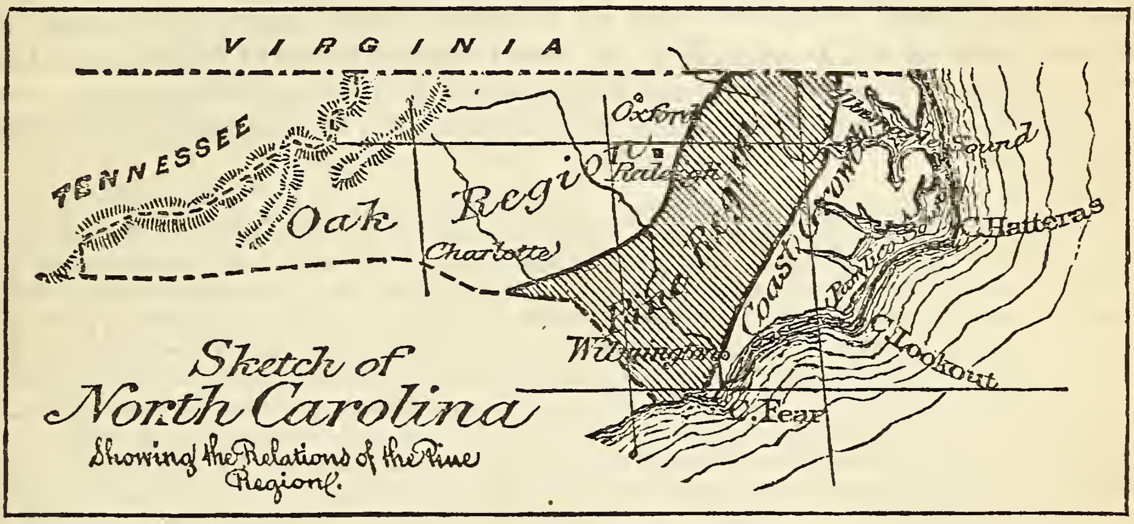
*These names are generally according to Michaux, and in some cases are different from those now generally adopted.

[1] *Experiments to determine the Comparative Value of the principal Varieties of Fuel used in the United States, and also in Europe, and on the Ordinary Apparatus used in their Combustion.* By Marcus Bull, Phila., 1827, 8 vo., pp. 103.

[2] The outer room was 11 by 14 feet and about 11 feet high; the inner one was cubic, 8 feet on a side, and containing 512 cubic feet.

RESINOUS FOREST PRODUCTS.

We have given in connection with the statistics of naval stores,[1] some account of the early history of this class of forest products. The principal source of our supply is the *Pinus australis* of Michaux (the *Pinus palustris* of Linnæus), commonly called the yellow or Georgia pine, a timber highly valued on account of its strength, elasticity, and durability in architecture and ship-building. It is found on a belt of country ex-



tending from a little south of the Roanoke River in North Carolina, through that State, South Carolina, Georgia, Alabama, and Mississippi, and into Louisiana, generally at a distance of 50 to 150 miles from the coast. In North Carolina, where it has hitherto been chiefly worked, it does not occur near the coast, except near the southern point, and its eastern limit would be in a line drawn nearly direct from the head of Albemarle Sound, to a point some 20 miles west of Cape Fear. The belt is about 50 miles wide at the north, and it widens as it extends southwestward, until its western border crosses the State line about 10 miles west of the Great Pedee River. Its area within the State is about 15,000 square miles, or about 30 per cent. of the State, and its elevation above sea-level, for the most part, is less than 200 feet. The soil of this region is generally light and sandy, and where there is a clay subsoil the timber is of better quality. On the richer bottom-lands other species, of coarser grain, known as the short-leaf, rosemary, and loblolly pines, are more common. This last-named pine (*P. taèda*) is generally of poor quality for timber, its sap-wood being very thick.

The best long-leaf pine has a thin sap, fine grain, and slow growth, requiring about a hundred and fifty years on the average to square a piece of timber 16 inches on a side. The tree appears under a great number of varieties, as its growth is modified by climate, soil, and exposure.

The trees are generally boxed in winter, by cutting into the side a hole about 3 inches wide, 6 inches deep, and 12 inches long, and the incision is enlarged from time to time by chipping out above. The flow of turpentine begins with warm weather in spring, is most in summer, and gradually ceases with the return of cold weather. The crude turpentine is dipped out of the boxes, the harder parts being scraped off with an iron instrument. In North Carolina the turpentine is collected about once a month, and 10,000 trees will in a good season yield 50 barrels of

[1] Reference is here made to the Statistics of Exportation and Importation of Forest products, not as yet ordered to be printed.

spirits of turpentine and 200 barrels of rosin.[1] The trees are scarified every year anew, and usually in large trees two or more boxes are cut. When dead, the tree is cut for tar, or sawn into lumber, but for uses requiring strength, trees that have been tapped are less serviceable, and are often rejected by engineers.

A pamphlet recently published in the interest of the Macon and Brunswick Railroad, in speaking of a region between the Oconee and the Ocmulgee Rivers, in Montgomery, Telfair, Dodge, and Laurens Counties, Georgia, and its resources in timber and naval stores, says that the estimated yield in yellow pine is between 10,000 and 12,000 feet per acre. Trees could be rented at $5 per thousand, could be chipped from 20 to 30 times in a season, and would yield from 8 to 10 dippings. Concerning the history of the turpentine industry, it makes the following statement:

Previous to 1820, the production of turpentine was very small, being confined to the region of North Carolina, between the Cape Fear River on the south and the Tar River on the north, the shipping depots being Wilmington, Newburn, and Washington. Distillation was done to a very small extent, and in iron stills, upon plans very different from the present mode. Most of the products went to the northern ports, where some little was distilled, and the balance was shipped to Great Britain in the crude state.

Up to 1832, the getting of turpentine was confined to a space between the two above-named rivers, and within twenty-five miles of the shipping ports alluded to above, the quantity being sufficient for the consumption of this country, and export to Great Britain. In 1834, great improvements were made in distillation by the use of copper stills, when the product was increased, and new distilleries were erected at shipping points. In 1836, the manufacture of India-rubber goods caused a new demand for spirits of turpentine, increasing its value greatly, and creating a new demand for territory near shipping points. Up to this time it was considered that the country on the west and south sides of the Cape Fear River in North Carolina would not yield turpentine. A test being made in 1837, the error was discovered, and the business extended rapidly in that direction.

After 1840, many of the operators left the old region, to operate in the new. Up to 1844, no distilling was done away from the shipping points, all being sent in from the country in the crude state, and was manufactured about as follows: one-fourth in North Carolina, one-fourth in northern cities, and one-half in Great Britain. Some spirits of turpentine was used for illuminating purposes as early as 1832, in mixture with high-proof alcohol. About 1842, rectified spirits of turpentine began to be used largely as an illuminator, under the names of *camphene, pine-oil*, &c. The mixture with alcohol was furnished under various new names, and at cheaper rates (the patent having expired), and was the cheapest light known until the discovery of petroleum, which has displaced it.

The increased demand for spirits of turpentine caused the production to increase, and the gathering extended to States south, embracing South Carolina, Georgia, Florida, Alabama, and Mississippi. The quantity of rosin produced exceeded the demand, and was not worth the handling, even at the ports. This caused distilling to be done as near producing points as possible, which carried into the country numerous distilleries.

Previous to 1846 the tariff of Great Britain was such as to exclude imports of spirits of turpentine and rosin. Free trade, however, was then authorized in spirits and rosin, as well as crude turpentine, and shipments were made of all grades; the manufactured increasing and the crude decreasing, up to 1861, when business became closed.

Upon the opening of business in 1865, there was some stock on hand of spirits and rosin in the South, which, with the old crude on hand, constituted the business until the new crop of 1866 came into market, since which time the production has continued regularly, but has not at any time reached an amount equal to 1860, the many uses of the products of petroleum, where spirits of turpentine had before only answered, having reduced the demand, and caused prices, in some localities, to be unremunerative, especially off from railroads or rivers, the hauling being expensive.

The southern districts of France supplied Europe with turpentine during the years

[1] The yield of soft turpentine is 10 to 12 pounds to a box, or 20 to 25 to a tree of usual size. The boxes hold about three pints. A barrel of crude turpentine will yield 5 gallons of spirits of turpentine, and 62 to 65 per cent. of its bulk in rosin. The tapping of the first year produces the fine light resin, and it grows darker from year to year. A distillery of 40 barrels' capacity will distill crude product from about 350,000 boxes.

that its exportation from America was interrupted. The trade with Europe, previous to 1861, was done mostly by way of New York. Now almost all of foreign consumption is supplied by direct shipment, experience having proved that to be the most economical course. The distillation of turpentine has ceased in Europe, outside of France, as also in the States north of North Carolina, and, excepting the small portion distilled at some of the ports in North Carolina, all supplies come now from the country as spirits and rosin. At present the prices of naval stores are low, having felt the effect of the late general depression, but it is to be hoped there is a better future for business, in which event this branch will share the benefit.

The product of spirits of turpentine and rosin for the crop of 1876 in the United States may be computed in round numbers at about 300,000 casks of spirits of turpentine, and 1,500,000 barrels, of 280 pounds, of rosin. This would not be in excess of consumption in years of general prosperity.

The Franco-Prussian war interfered with the production of naval stores in France, causing the supply for 1871 to fall short. This caused a speculation, and put prices much above the usual rates, causing an excess of production and lower rates. There has been no recovery from this up to the present time.

Several letters from manufacturers give the following additional information concerning the turpentine interests of the South:

We are paying our laborers from $15 to $20 per month. We select our hands in paying these prices, and work them by task where practicable. * * * We chip our boxes from 25 to 30 times during the season, and get from 8 to 10 dippings. A hand chips from 10,000 to 12,500 boxes per week for a task. We dip from three to five full round barrels, 280 pounds each, per 1,000 boxes, and pay from 20 to 30 cents per barrel for dipping, the hand boarding himself.

We generally get from 10,000 to 12,500 boxes on 202½ acres of land, which is a lot in our county. Lands in this country are generally divided into what are called "lots," and a lot hereabouts is 202½ acres. Much depends on the superintendent of the cutting, as some have them cut much thicker in the pine, or more boxes per pine, and some have a good many small pines cut. I suppose there would be 4,000 or 5,000 pines in a 10,000 or 12,500 task of boxes. Very much would depend on the locality in which they were cut, as the timber is much larger in some places than in others. The pines here are generally large. Ten thousand boxes is the usual task of a chipper, though a good hand can chip 12,500.

Lands can be bought for from 50 cents to say $5 per acre, as per location, &c.; or they can be rented for $5 per 1,000, or $50 per lot of 202½ acres. We estimate a yield of 6½ gallons of spirits from a barrel (280 pounds) of crude turpentine, and 186 pounds of rosin. Spirit barrels cost $2 to $2.50 apiece, delivered; kerosene $1.25. There is a new way, however, here for transporting spirits of turpentine when shipped to certain points, which does away with spirit barrels altogether. Kerosene tanks on cars are used. The spirits are put into these iron tanks right at the still, and thus transported in bulk, as it were. They are of course tight, and hold about 3,500 gallons. There is also a saving in freight, not only because the weight of the barrel is dispensed with, but a low through Green-Line rate is allowed.—(*J. E. Orerry*, Cochran, Ga.)

INSPECTION LAWS RELATING TO RESINOUS PRODUCTS.

In several of the Southern States, laws have been passed regulating the inspection of turpentine, &c., and defining its grades. The principal of these are as follows:

Virginia.—Barrels to be full of good, clean, sound, and merchantable tar, pitch, or turpentine, and to hold 31½ gallons.

North Carolina.—Soft turpentine barrels to weigh 280 pounds gross, and hard turpentine, 240 pounds; pitch, 32 gallons to the barrel. Turpentine, tar, or pitch to be free from fraudulent mixtures. Casks to be of good seasoned staves, ¾ of an inch thick, and not over 5 inches wide; not less than 30 nor over 32 inches long. Heads not less than 1 nor more than 1½ inches thick. To have 12 hoops to a cask, except hard turpentine, which may have 10 hoops. Water is declared not a fraudulent mixture of tar. Tar and turpentine barrels not limited as to weight, but the weight to be marked and certified. Turpentine to be branded "S," or "H," for soft or hard, and to show the initials of the maker's name. The inspector of naval stores at Wilmington is to gauge all spirits of turpentine.

South Carolina.—A barrel of crude turpentine to weigh 280 pounds, gross.

Georgia.—Inspectors of turpentine, &c., may be appointed by cities, and their duties prescribed. Soft turpentine to be put up in barrels, as in North Carolina, and to be branded "V," for virgin turpentine; "S" for yellow dip, and "H" for hard.

Florida.—The governor may appoint inspectors of tar and turpentine. Makers required to brand their initials on the barrels. Inspectors are to mark the products that come under their notice as follows: "V" for pure virgin dip, "D" for pure yellow dip, "S" for pure scrape. If the first two of these be impure or mixed, the "V" or "D" is to be inclosed in a circle. If the scrape is not passable, it is marked with an "X" in a circle.

Allowances and deductions are to be made on turpentine with reference to the following particulars:

1st. When virgin dip is dipped from burnt boxes, or contains burnt cinders, or sand.

2d. When virgin dip is mixed with chips, bark, or other impurities.

3d. When virgin dip is mixed with yellow dip, or scrape.

4th. When yellow dip is mixed, or contains chips, straw, bark, scrape, or sand, or other impurities.

5th. When scrape contains more chips than are absolutely necessary to get it off, or dirt, or other impurities.

6th. When yellow dip, virgin dip, scrape, or tar contains water, or there is an excess of wood in the barrels containing it, or it is injured by long standing or leakage.

7th. When tar or turpentine of any class is contained in insufficient or unmerchantable barrels.

The size of barrels is fixed at 30 to 32 inches in length, and the weight 280 pounds, gross, for turpentine, and 320 for tar. Allowance is to be made for deficiencies, and records are to be kept, but inspection is not obligatory upon the producers of tar and turpentine in this State.

Alabama.—Inspectors are to be appointed by the cities, and their duties prescribed by municipal law.

RESINOUS PRODUCTS OF FRANCE.—These are chiefly derived from the maritime pine (*Pinus pinaster*, L.), which begins to yield resin abundantly when 25 to 30 years old, and when the process is well managed it will continue to yield for a very long time. In the forest of la Teste are some pines with as many as 60 scars of places where they have been tapped. Supposing that they were made new every fourth year (they generally are once in 5 years), the working of these trees goes back 240 years, or, adding the years of youth, to 270 years. It is difficult to tell what is the period of greatest annual production, but, according to what we see in nature, it is not near the beginning nor the end of a tree's life.

It is easier to describe the pine that is the best producer of resin. The tree is short, thick, stout, the head well developed and well set with branches; in short, such a tree as we might call *apoplectic*. Its girth at a meter above the soil ought to be 1.1 meter (43 inches), that it may be able to endure tapping without injury, and its height to the branches should be, among the dunes, from 6 to 8 meters (about 20 to 26 feet), while in the Landes it would be 12 to 15 meters (40 to 50 feet). The tufts of six or seven pines would fill a stère. Such a specimen can only be found in open woods, trained regularly, and containing not more than 65 to 80 trees to the acre. It is further observed that the nearer we approach the sea, the slower the growth of wood becomes, while the amount of resin increases both in quantity and quality. We have already seen how much less length of trunk is required in the dunes, when separated from the sea and sheltered by them. The annual production of a tree varies from 3 to 4 liters, weighing 1½ to 2 pounds each. There is no definite relation between the volume of the stem and the production of resin. It is most when the tufts of leaves are best developed.[1]

---

[1] *Revue des Eaux et Forêts*, 1875, p. 97.

The maritime pine produces turpentine best near the sea, and on warm, gravelly soil or rock formations than upon clay, and still better than upon a peaty soil. In a young plantation, the extraction of resin is begun on the trees that are to be felled before the end of the rotation, and before it begins the lower branches are trimmed off, so as to obtain a clean stem at least five meters high.

Two methods of resin-tapping are practiced, known by the French as *gemmage à mort* and *gemmage à vie*, the former killing the tree after a time, as its name implies, and the other not. In either case, a rectangular piece of bark is peeled off near the root, about 5 inches wide, and extending up at first about 4 inches. A little wood is taken off with the bark. Formerly the resin was allowed to flow down to the ground, where it was received in a little hole hollowed out in the sand, or boxed into the tree; but now a curved strip of metal-zinc or tinned iron is driven in under the incision, turns the drip from the tree, and it is caught in small earthen pots, glazed on the inside, and supported by stout wires driven into the tree. These metal lips and earthen pots are carried higher up the tree as the operation is continued, and the latter are sometimes covered to reduce the evaporation of volatile parts. The operation of scarifying is done with a light axe with a curved blade, and the wound is opened and extended a little once or twice a week by taking off a little fresh wood, and extending it up; and so the process continues until the opening becomes some 10 or 11 feet long. The printed stipulation which contractors are bound to follow when working in the State forests is to not allow the opening to exceed 5 inches in width and 1 centimeter in depth. Such a square may be worked for five years, being lengthened the first year 55 centimeters, and in the next three years each 64, and in the last year 67. It is then left, and the wound heals up by the formation of new layers of bark and wood, a swelling being formed over the place. Old trees will often show several of these swellings, indicating the service to which they have been put. Unless the tree is to be saved, no care is taken for healing, and new squares are opened until the tree is finally dead. In private forests the openings are sometimes extended up 16 feet, and two or three are worked at once. In trees that are to be cut in thinning a forest, the tapping begins when about two feet in girth, and they generally die in three or four years. A part of the resin drying on along the opening, is scraped off once or twice in a year.

The use of lips and pots is known as the method of Mr. Hughes, and although it requires a heavy outlay at first, is found to possess the advantage of yielding more resin, in a purer condition; the result, according to M. Samanos, as compared with former methods, being as 4 to 3.

Resin-tapping is carried on only between March 1 and October 15, but the gradual thinning off of the bark is begun as early as the 10th of February. The yield is greatest in trees about forty centimeters (nearly sixteen inches) in diameter, and about three liters (183.1 cubic inches) by the conservative process; but taking into consideration the continual diminution in number of trees, an hectare yields about three hundred and forty liters (about thirty gallons) a year. It is not easy to calculate the yield by the destructive process, but it is generally admitted that from two hundred to two hundred and fifty pines, 20 centimeters (8 inches) in diameter, will yield the above amount for three years.

M. Bagneris mentions a pine, 4 meters around and 11 meters to the first limbs, which had 10 "squares" working simultaneously, yielding seven to eight liters of resin annually. The price of crude resin is quite

variable, sometimes as low as 40 francs a cask (340 liters, or about ninety gallons), but during the late American war, when supplies were cut off from this source, it rose to 290 francs. The resin-tappers are paid by the cask, usually thirty to thirty-five francs, which allows them to earn from four to five francs a day. In distilling, the crude resin is melted, strained, and conducted to the still, into which a thin continuous stream of water is introduced by a funnel. The water becomes steam, which carries over the turpentine vapor, when they are both condensed, and then separated by decantation. The residuum is then passed through a sieve, which separates it into two grades of rosin. The black rosin boiled with tar forms pitch, and all of these special products have their special uses in the arts. The residuary products of distillation, about pay the cost of the process, leaving a small profit besides the spirits of turpentine. By heating the black rosin to a high temperature, a double decomposition takes place, resulting in the separation of certain volatile oils used in varnishes, or of certain fixed oils that are used for illumination, lubrication, impregnation of wood, the manufacture of printer's ink, and other uses.

Opinions are divided as to the effect of tapping upon the durability of the timber. The flow of resin fills the sap wood and increases the durability of this part, so far as it is affected. The annual layers become less, and the proportions of fall growth relatively larger. But the wood that forms over old " squares," is neither continuous or regular, and it is unfit for lumber; but being saturated with resin it is durable and may be used for many purposes, such as staves for resin-casks, trellises, &c.

The maritime pine is used for railroad-ties, being the chief timber for this use in the south of France and north of Spain. It is also used for charcoal and fuel. Its cultivation, besides fixing the dunes and sandy lands over nearly 2,000 square miles in the department of the Landes alone, and about as much more in the Gironde, and furnishing the products above enumerated, has done still further service by reclaiming low, marshy lands which had before been pestilential, and rendered them healthy and productive; introducing business, health, and comfort where there was nothing but wretchedness, sickness, and poverty. The intelligence which has wrought these changes will take care that this region does not again become a waste of treeless moors and naked sand-hills, which will only be remembered as things of the past.

An account of the methods practiced in Russia for the extraction of resin, is given in our notice of the forestry of that country. The yield is much less than in the forests of maritime pine in France.

In the spruce, the resiniferous canals are found most productive in the iber, and may be opened without wounding the wood. But this more or less weakens the tree, and it then becomes an easy prey to insects. For these reasons they are not much tapped for their resinous products.

Resinous products of Russia.—The extraction of resinous products in Northern Russia is regulated by specific rules, which are described in an article from a Russian journal as follows:[1]

Two distinct methods of working are simultaneously practiced in each series, according as the material is obtained, directly or by distillation. For the direct production of resin, they take trees when they have reached the height of about six metres (20 feet) and a thickness of three and one-half to seven inches, and remove the bark, for a length of twenty-eight inches, from almost around the tree, leaving only a strip two

[1] This account is translated from the article as published in *La Revue des Eaux et Forêts*, for September, 1876.

or three inches wide to keep up some circulation and prolong the life of the tree, which, after this, takes no growth of the trunk except at this place. The strip of bark left is by preference on the north side. In the autumn following they take off the resin with a scraper, getting about fourteen ounces avoirdupois from a tree. The next year they take off the bark some sixteen inches further up; but this should not be done at one time, but successively, in narrow strips. The narrower and more numerous these can be the greater will be the product, which may be brought as high as twenty-one ounces to the tree. On the third year the same process of peeling is renewed, with similar result. It is also done the fourth year, but the yield is then only fourteen ounces. On the fifth year they take off at once a piece of bark 24 inches long, but the yield is then but small, and on the sixth year the peeling is stopped; but they leave the tree standing three or four years longer, so that it may become filled with resin, for which it is then cut and carried to the tar-oven. The operation, therefore, lasts from five to ten years, but in late years this period has been somewhat abridged. The more slowly the resin is drawn the more the wood is gorged and brown with resin when cut. It is forbidden to carry the peeling higher than 3.7 meters (13.8 feet), and there should always be reserved a proper number of trees left for seed, and left without peeling.

There are 136 tar-ovens in the district devoted to the working of resin, each holding about 2 stères (2.6 cubic yards) of wood, and yielding in a day and a half 132 to 147 kilograms (289 to 324 pounds) of tar, and over 33½ pounds of yellow turpentine. The tar is sent to Archangel, either crude or in the form of pitch, 25 quintals of tar yielding 13 of pitch, and 164 kilograms (361½ lbs.) of turpentine. From the resin drawn from the wood while standing they make colophony, and about 5 per cent. of the best white turpentine.

A reduction in the time allowed for the trees to stand after peeling is not wise, because the longer they are allowed to stand the more filled with resin they become and the more profit can be derived. This fault in working is due to two causes, a wish to distil the wood as soon as it gets charged with resin, and the manner in which the mode of payment is required. The forest-tax is calculated by taking for its basis the amount of products obtained, or to be obtained, or so much per ton for the tar. Besides, a control somewhat difficult but necessary must be had as to the number of tons produced by each oven, without taking account of the more or less quantity of wood distilled in reaching this result, or the number of trees cut. On the contrary, were the peasants allowed the use of a given area of land, they would devote their whole attention to making the trees yield as much as possible. The tax in this case would be very easy to fix, because, from a course of experiments made specially for this object, it could be ascertained how much on average a given area would yield, or how much from a tree in certain conditions. They estimate that 48.5 stères (13.3 cords of 128 cubic feet) will make about a tun (330 gallons) of tar. From 1862 to 1872 they obtained from 42,642 cords (of 128 cubic feet) 79,363 tuns of tar, from which a revenue of 64,525 roubles was derived, and from the resin, 5,412 roubles, making a total of 69,337 roubles ($52,002 75). In round numbers this was 7,000 roubles per annum for 80,000 hectares ($5,250 for 148,260 acres), or 3.6 cents an acre. It requires, however, much care to maintain the trees that exist, for the growth in these northern regions is so slow that trees 8.5 meters (28 feet) below the branches, and 5.1 inches through, often show more than 110 layers of annual growth.

PERFUME FROM PINE SAP.

The Academy of Sciences, on the 14th of September, 1874, received a note from M. Hoffman, in which he announced that two of his pupils, Hermann and Tiemann, had succeeded in obtaining, by special chemical reactions upon the sap of the pine, a perfume resembling the vanilla of commerce; a tree of average size, without injuring the wood for use, affording this product, worth 100 francs. It has since been obtained, not only from the *Pinus sylvestris*, but from *Abies excelsa* and *A. pectinata*, and it is supposed that it can be got from other conifers. To obtain this sap, the trees are cut down, peeled, and the sap scraped from the outside of the wood and inner side of the bark. This semi-fluid mass, which soon tends to ferment, in order to be kept till it can be used, must be boiled some minutes to coagulate the albumen, when it may be put into barrels or tin cans, and sent to the manufactory, where it is submitted to chemical treatment, the details of which cannot well be here given. Experiments are now being made to determine the various elements of cost and other facts that may tend to form the basis of calculations relative to production and use. The timber, it appears, can only

be cut when the sap is most abundant and the bark most easily peeled; but the saving will prove so much clear profit, above cost of collection and manufacture. The perfume obtained from the cambium of the pine is now found in market, in the form of an alcoholic tincture, which is sold at a price not more than two-thirds as great as that of vanilla.

PINE WOOL.

There has existed near Breslau for several years, an establishment for the preparation of a fibrous substance from the leaves of the *Pinus sylvestris*, which possesses many valuable properties. The needle-shaped leaves of conifers generally contain a fine tenaceous fiber enveloped in other tissues, and a resinous substance, from which it may be separated by boiling with certain chemical reagents and by washing. The fiber is fine or coarse according as it is prepared, and may be used as cotton or wool in mattresses, or it may be spun and woven. In 1842 a quantity of woven fabric of this material was introduced in place of cotton in the hospital at Vienna, where, after several years' experience, it was renewed. Among its advantages are that its odor repels insects, while it is salutary and agreeable to those using it. It has also been used in prisons and hospitals at Berlin, Breslau, and other places with increasing favor. As to durability in mattresses, it is found to last three times longer than wool. When spun and woven it has the strength of hemp, and it may be made into carpets, blankets, and other articles.

In the preparation of this wool an essential oil is obtained, having an agreeable odor, and a green color if kept in the dark, but when exposed to the light it takes an orange color, returning to its original tint in the dark. It is used as a liniment in rheumatic complaints, wounds, and certain cutaneous diseases. It may be used in varnishes or for illumination, and is a solvent of caoutchouc. The waters left in its manufacture are used for bathing, and are reputed to have much medicinal effect. In concentrated form these waters are put up in casks for those who wish to use them at home. (*Giornale delle Arti e delle Industrie; Revue des Eaux et Forêts*, i, 279.)

TANNING MATERIALS.

The principal tanning materials produced and used in the country are hemlock and oak barks, and full statistics of their importation and exportation are prepared for the statistical part of this report. As a rule, the bark of the hemlock, (*Abies canadensis*), is the principal material used in the Eastern, Northern, and Western States, but little of it being used south of Pennsylvania. There are comparatively few oak tanneries of considerable extent within the above region, but quite a number in the southern border of Pennsylvania, and in Maryland, Virginia, West Virginia, Kentucky, and States farther south.[1]

---

[1] The first shipment of leather to England was made about 30 years ago, consisting of 500 sides, worth $2,000. The war stopped all efforts in this line, but in 1869 the amount exported was valued at $132,709, of which much the greater part went to the West Indies. The arming of nations in Europe in 1871, and increased prices, created a demand, and in that year $1,062,366 worth of sole-leather was shipped to Europe, of which $600,000 went to Liverpool and $48,000 to Hamburg and Bremen. The total shipments of the year were $1,690,252. In 1872 they were more than doubled, amounting to $3,471,582, and in the five years ending in 1875 the total shipments amounted to $22,161,972.

Four-fifths of the leather sent to New York is made in Pennsylvania and New York, only six tanneries sending oak sole-leather, the rest hemlock, excepting 35 or 40 union tanneries. These are largely owned or the capital is furnished in the city of New

Several large manufactories of tanning-extract were established some years since in Canada for supplying the English market, but owing to the depression of prices there, they are shipping their extract to the United States. The low wages that they pay, and the comparative cheapness of bark, which may be had from the crown lands at a very low price, enables them, it is said, to do this with advantage, although the duties are 20 per cent. on the valuation.[1]

According to the census of 1870, the number of tanneries in the United States was 7,569, of which 1,495 were in Pennsylvania and 1,002 in New York. There were employed 35,243 persons and $61,124,812 in capital. The annual wages paid amounted to $14,505,775; the materials used amounted to $118,569,634, and the product was valued at $157,237,597.

The annual report of the secretary of internal affairs of Pennsylvania for 1875–'76 contains reports from 172 establishments (less than one-fourth of the whole number in the State), which show the annual product in leather as 25,934,107 pounds; persons employed, 1,706; domestic hides tanned, 392,485, worth $1,947,377; foreign hides tanned, 359,163, worth $1,884,477; calf-skins tanned, 38,403, worth $42.903. Total value of hides and skins tanned, $3,874,757, and value of bark used, $964,884.[2]

A firm doing extensive business in the State of Maine estimates that the bark within their knowledge yields 3 cords to the acre; that 4 to 6 trees will make a cord of bark and 1,000 feet of lumber, and that in ten years, "at present rate of use, there will be no hemlock in Maine of any amount." We have not been able to learn that in a single instance hemlock timber has yet been planted within the United States with the view of supplying bark for future use. Much of the timber now standing is fully ripe, and some of it is perishing.

If the area of timber now available for this use were definitely known, it would be very difficult to calculate its duration, because it is liable to casualties that may be even greater than the amount used for tanning purposes. The principal of these are fires and wind. In peeling bark, the tops, and often the whole trunk, is left on the ground, and a fire once started in a dry season could scarcely be controlled while any of

York. The exports in 1875 from New York were 11,974 rolls, 31,248 bales, 546 cases, 1,739 bundles, 12 boxes, 9,222 packages, 17,713 sides, and 9 casks; total value $5,338,704. The imports of New York for that year amounted to $319,108.06; 3,764,822 pounds coming to New York in 1875; 2,759,309 were brought by railroads, and of this nearly half (1,094,610) by the Erie Railway. (*Annual Report N. Y. Chamber of Commerce*, 1875–'76, part ii, p. 120.)

The receipts of leather in Boston for the year 1876 were 1,778,182 sides, 578,970 rolls, 153,063 bundles, 40,350 bags, 7,390 bales, 4,047 sacks, 5,929 packages, 603 crates, 3,959 cases, 639 boxes, 180 barrels, 109 casks, 28 hogsheads, 35,834 pounds, 239 pieces, and 2 cars.—(*Shoe and Leather Reporter's Almanac*, 1877, p. 30.)

During the year 1875 there were sent from Philadelphia by steamers 1,406,162 pounds of hemlock extract to Liverpool, and 497,154 pounds to Antwerp. This was mostly from the works at Elmira and Painted Post, N. Y.

Nearly a hundred years ago a considerable amount of ground oak bark used to be shipped from Baltimore and Philadelphia to England. Its cost here then was $4 a cord.

[1] During ten years ending June 30, 1877, the quantity of extract of hemlock bark exported from the Dominion of Canada amounted in all to 171,996 barrels, valued at $1,745,244. Of this, 72,132 barrels, worth $621,014, came to the United States.

[2] The largest sole-leather tannery in the world, according to the Shoe and Leather Reporter's Almanac for 1876, is the Wilcox tannery, in Elk County, Pennsylvania, which for several years has manufactured about 200,000 sides of hemlock sole-leather per year. For the last two years it had tanned nearly all the bison-hides coming to New York. Next to this comes the Eagle Valley tannery at Ridgeway, Pa., tanning 150,000 sides, and the Kingman, Jackson Brook, and Vanceborough (Maine) tanneries, producing from 100,000 to 130,000 sides each year.

these dry materials remain unconsumed. The only protection against forest fires appears to be constant vigilance and stringent regulations faithfully enforced.

Another source of damage consists in the liability of large trees to be thrown down by the winds when open clearings are made exposing the standing timber.

It is a matter of common experience that extensive areas once covered with a heavy growth of hemlock, as, for example, in Greene and Ulster Counties, New York, have, within a period comparatively recent, been wholly or nearly exhausted of their tanning materials,[1] and that extensive tanneries in many places have been wholly abandoned, their owners, if continuing the business, being compelled to seek new localities. Under the best manipulation, a cord of good hemlock bark will make about 200 pounds of sole-leather.[2]

Various substitutes for hemlock and oak barks have been tried with some degree of success.[3]

CULTIVATION OF OAK COPPICE FOR TANNING MATERIAL.

From present indications it seems probable, that our future reliance must be placed upon the cultivation of oak coppice. It will therefore be of interest to notice some of the principles concerned in the production and preparation of this material in other countries.

It appears from official reports, that in countries where great attention is paid to the development of forest resources, the production of oak bark is steadily increasing, and that its price is advancing, having

---

[1] Where lands are allowed to lie after the hemlock timber is cut off in this region, the succeeding growth is chestnut, oak, birch, beech, or poplar, but never hemlock.

[2] A calculation based upon the returns of 12 large hemlock sole-leather tanneries in Pennsylvania, using 64,316 cords of bark, and making 10,727,528 pounds, shows the average to be 166 pounds of leather to a cord of bark. The highest yield was 200 pounds in the tanneries; the lowest 122 pounds.

Returns from 12 oak sole-leather tanneries gave from 15,947 cords 2,520,919 pounds, or an average of 159. The largest yield was 231 pounds; the least, 126.

Two tanneries making oak harness-leather showed a yield of 292 and 294 pounds to the cord. In buying hemlock bark, a cord is reckoned equal to a ton, and the practice of weighing instead of measuring bark is apparently on the increase.

At a Hide and Leather Convention held in New York City in October, 1877, resolutions were passed recommending the purchase of hemlock bark by the ton of 2,000 pounds, instead of by measure, as preferable throughout the whole country.

It is estimated that the French tanneries employ 300,000,000 kilograms (330,690 tons) of bark annually. The exportation of ground bark somewhat exceeds the importation. (*Nanquette.*) The bark from a stère of oak coppice of thrifty growth will make 30 kilograms of dry bark. Trees of two revolutions (*modernes*) give per stère, 40 kilograms.

Taking a general average of the hemlock forests of Northern New York, the yield of bark may be estimated at 3½ cords to the acre. Under the most favorable circumstances, it may come up to 10 cords. Much waste has occurred, and is now going on, in this region, the price of hemlock lumber being so low that much of it is left to rot on the ground. Of course no provision whatever is made for reproduction, or for disposing of the rubbish by careful burning, and the decaying timber remains, the breeding place of injurious insects and the aliment of running fires, the waste from which has been very great. The longest estimates fix the period of exhaustion, within reach of existing tanneries in Lewis County, at fifteen years. At an extensive manufactory of tanning extract in that county, the yield is about 400 pounds to the cord.

[3] The bark of the red pine (*Pinus contorta*, Dougl.) has been used to a limited extent at Salt Lake City, Utah, as a tanning agent, the price paid being from $12 to $40 per cord. It is estimated by a practical tanner that it has about two-thirds the value of hemlock bark. The supply is scanty, and wholly derived from the cañons of the Wahsatch Mountains, where the wood of this species is obtained for lumber.

The *Polygonum amphibium* (water smart-weed), growing wild in abundance, has been used to some extent in Nebraska, and the extract is prepared in Iowa. The sweet fern and some other plants have been used.

within 30 years arisen 80 per cent. in France, with a still upward tendency. In 1874 the gain was 6 per cent., and in 1875 it was estimated that the increase would be 20 to 25 per cent., which was in a large degree realized. As the value of bark enters largely into the estimate of profit of growing oak coppices, it becomes of the highest importance to determine the circumstances that give it greatest value, and the age at which it can be cut to best advantage, as the relations between weight, volume, and value of wood and bark, and of tanning material in the bark, are changing with the growth, and even at a given time are different in the several parts of the same tree.

Time of peeling the Bark.—Oak must be peeled between the time that the buds begin to swell and the appearance of leaves. It peels best in cold, damp weather, and not so well when dry and hot. North and east winds more or less hinder the process. When vegetation is suspended by a series of cold days, as may happen in the north and east of France, they are obliged to suspend the operation of peeling, and the process may hold on till midsummer or till after the leaves are fully out.

Bark is usually peeled from the tree standing, as far up as can be reached. The upper part and branches peel easier. It must be done when the tree has been felled, and often a day or two after the trunk has been peeled.[1]

The yield of bark in an oak coppice can be estimated within 5 per cent. by sampling a few trees, weighing the wood and bark, and allowing a loss of one-third in the weight of bark in drying. Of course, with a number of trees given, the calculation becomes easy, and the average result quite near.

A considerable extent of woodlands in Scotland is devoted to the raising of oak for tanning and for the wood. The age at which cut, depends on the soil, situation, exposure, and mode of rearing, and is determined by the appearance and condition of the bark. On damp soils, where the bark is much covered with mosses, and becomes rough at an earlier age, it may be cut in fifteen years; but, as a general rule, twenty years is there considered the best, as the bark then contains relatively more tannin than at any other time. In older trees the corky, rough outside bark has less or little value to the tanner. The best bark comes from trees in a healthy growing condition, with a thick, juicy liber, and that are cut during the ascent of the sap before the leaves have expanded. The bark of a tree in full leaf is quite materially less in value than when cut before the leaves appear. Where proper attention is given to the cultivation, the brush is cleared off at the time of cutting, and if there be ditches for drainage, these are cleaned out and repaired.

Before cutting, a ring of bark from the root up to 30 inches is peeled off. After cutting, the tree is trimmed and cut into convenient lengths. All branches down to an inch in diameter are peeled, and in the smaller pieces it is first loosened by beating with a mallet upon a stone.

When peeled, the bark is spread upon poles some 3 feet above the

[1] The quality of bark is good in proportion as the liber is of much thickness and gorged with sap from vigorous growth. It is best from young trees with active vegetation and in a warm climate.

The "*yeuse*" oak is best of all, the "*touzin*" oak next. They grow along the Mediterranean and in the southeast of France. The *Quercus sessilifolia* and *Q. pedunculata* furnish most of the bark used in French tanneries, of which the former is best. Peeling reduces the volume of wood a fifth or sixth part.

Schistose and granitic soils with a warm aspect furnish the best bark. It is estimated that 50 to 55 kilograms of dry bark are got from a stère of fire-wood. Mean price, 10 to 12 francs the 100 kilograms dry bark, delivered in port or railroad depot; about half this price is absorbed in handling and freight. (*Nanquette.*)

ground, inside down, and in ranges on piles 18 inches deep, the top being covered with the largest pieces, as a shelter from rain. Bark while drying is much injured by rain.

When it has been three or four days on these stages, it should be stirred and opened a little to prevent molding. It takes from two to three weeks, according to the weather, to dry the bark of such coppice oak; but under very favorable circumstances it will dry in eight days. Properly cured bark is of a light cream-color, and breaks freely. If damaged by the weather it is of a brownish color, indicating a part of the tannin has been taken out. When dried it is taken to sheds, broken into small pieces, and sold in sacks to the tanners. The bark should be peeled the same day the tree is cut, or at latest the next day. A genial shower after cold weather makes the bark peel more easily. Much of the peeling, especially of the small pieces, is done in Scotland by women. The larger sticks of peeled wood are sold for spoke timber and other industries, and the smaller to the chemical works for fuel.

The European larch thrives extremely well with the oak, and is often planted to fill up vacant places. The bark is easily stripped, and when taken from young trees brings nearly as high a price as second quality of oak bark. It thrives best on dry soil, and its foliage is open, admitting much light. No other timber does so well with oak as the larch.

By the common method of procuring the bark of young oak coppice wood, it can only be peeled in summer, when the sap is up, and according to the above experiments, when the tannin is in relatively smaller amount, and the wood of the least value. But by a process first proposed a few years since by M. J. Le Maitre, the peeling may be done at all seasons, instead of the brief and variable season formerly allowed. This consists in steaming the wood in an air-tight receiver of any convenient size and form. The inventor died before seeing his process adopted as a branch of industry, but it has since been perfected by M. de Nomaison.[1]

According to the researches of M. Wohmann, oak wood cut in the winter, or while the sap is at rest (September to January), is denser, all circumstances being equal, than in summer. He found that a cubic meter of young oak in winter weighed 1.097 kilograms, and that it yielded 165 kilograms of bark, while, if cut in summer, it weighed only 892 kilograms, and yielded but 148 kilograms of bark. This interesting result confirms very satisfactorily the theory of alimentary reserve in the physiology of timber growth. A notable advantage is gained, if the coppice for peeling can be cut in winter, because the stumps will sprout again for a new growth with much more vigor and certainty than if cut in early summer. But a disadvantage is met, in the steaming process, by the fact that the tannin is less soluble and more difficult to extract than when peeled in the sap season. In fact, this appears to be the only weak point in M. Le Maitre's method.

[1] The Director-General of forests in France, wishing to determine with exactness the results obtained by the apparatus of the latter, some months since appointed a commission of forest agents, wood merchants, and tanners to examine and report upon this invention. This commission was placed under the presidency of M. Meynier, administrator of forests, and consisted in all of eight professional foresters, three wood merchants, and two tanners. Their labors began in January, 1876, in the domainal woodland of Viroflay. They were at once able to see that the bark was readily loosened; but it remained to be shown by careful study how the results compared, as to quality with those of bark peeled in the ordinary way. A Prussian commission has also been appointed to examine its merits. The process is deemed too new, and the results too uncertain, to afford a safe basis for estimating its real value.

EXPERIMENTS UPON OAK-BARK FOR TANNING PURPOSES, BY DR. BAUER, OF WÜRTEMBURG.

The growing importance of questions relating to the supply of tanning materials, for which the forester must provide, induced Dr. Bauer, one of the professors of the Forest Academy at Hohenheim, and director of experimental forest-stations in Würtemburg, to undertake in 1872 a series of observations with a view of settling some of these questions. Without following in detail the methods pursued, we will state the principal conclusions at which he has arrived. It may be remarked that observations were undertaken in France, in 1866, for this same object, by M. Bouvart, a forest inspector, and that there is a general agreement of results, allowances being made for differences due to soil, exposure, and climate between places widely separated. In fact, this agreement appears to indicate that these influences have really less effect than had been formerly supposed.

It is generally admitted that we have not sufficient means for determining the volume and the absolute and specific weight of oak-bark, whether green or dry, or whether growing in the forest or in open fields, nor to estimate the yield of bark, although all of these data are of great economic and scientific importance. The forester may be called upon to estimate as exactly as possible the bark on a given cutting, which may perhaps be sold in advance, because the purchasers need to know upon what to depend. The manner of keeping accounts may likewise require a change of expression from one unit of reckoning to another, as, for example, from quintals to cubic meters. A knowledge as to the loss of weight in bark by drying is also of great importance, not only in a scientific but in an economical point of view, because bark in wet years must often be transported in a green state. Finally, we cannot exactly determine the money value of oak fit for peeling without knowing the relative yield of bark and wood.

Although certain research had been made upon this subject, they needed confirmation by new examination, for which reason the commission charged with the direction of certain German forestal experiments, decided to undertake more extended observations concerning bark suitable for tanning. To obtain a more speedy conclusion, these experiments were in Prussia, made upon *old*,[1] and in Baden and Würtemburg upon *young* trees.

In Würtemberg, oak-bark is divided for market into the three following sorts:

1. *Glossy* or *shining bark*, obtained from all trees less than 12 centimeters (4½ inches) in diameter, including the bark, whether creviced or not.
2. *Average bark*, *i. e.*, bark both of stem and branches, from trees and shoots cut in the working of *futaie*,[2] and from 12 to 24 centimeters (4½ to 9 inches) in thickness.
3. *Coarse bark*, including the bark of trunk and of all branches of trees over 24 centimeters in diameter.

The price of the second is generally seven-tenths as much as the first, and the third is sold separately, the unit in all cases being the quintal.

Glossy bark is found chiefly in coppices managed specially for the production of bark, with a revolution of fifteen to thirty years, or in the underwood of coppice mingled with large timber; or, less frequently, in the trees cut in the first thinning of *futaie* Average bark comes chiefly from the younger reserves of coppice, mingled with large timber, and thinning of trees fifty to eighty years old. Coarse bark comes from old oaks, of all descriptions, wherever it appears worth saving, The experiments reported related chiefly to the first and second of these classes.

The experiments are described in detail, and tables are given in thirty-six separate cases, varied to meet as many different conditions as was practicable, and in each case showing—

The weight of green wood not peeled.
The volume of wood not peeled.
The specific gravity of wood not peeled.
The weight of green wood peeled.

---

[1] The term "*Vieilles écorces*," used in the article in *Revue des Eaux et Forêts*, from which we translate, is more strictly applied to trees left at the fifth revolution or thinning, by which forest-reserves are brought to their full maturity.

[2] Term applied to a forest raised to full maturity, and from which portions are thinned out from time to time.

The volume of a stère[1] of wood, after peeling.
The specific gravity of green wood, peeled.
The weight of green bark.
The volume of green bark.
The specific gravity of green bark.
The weight of bark dried in the forest.
The volume of bark dried in the forest.
The specific gravity of bark dried in the forest.

Without going through the details of these experiments the following comparison of results may be given:

1. The volume of a stère of peelable oak increases with age, and in proportion to the size of wood. In the case of trunks from peelable forests fifty-five to sixty-two years old, it is 0.725 cubic meters, and for coppice, 0.521. In the branches and trunks of full grown trees it is 0.430 cubic meters, and for the branches of coppice wood, 0.237.

2. The quantity of bark which gives a stère of wood separately is not proportional to the real volume, because then a stère from a plantation yielding "average bark" should yield much more green bark than one yielding "glossy bark," while the proportion is as follows:

A stère of peelable wood yields:

	Green bark.	Bark dried in the forest.
	Quintals.	*Quintals.*
"Glossy bark" from branches of coppice	1.50	0.76
"Average bark" from branches of full grown tree	2.35	1.30
Bark from trunks 16 years old	2.00	1.02
Bark from trunks 24 years old	2.74	1.52
Bark from trunks 38 years old	2.48	1.49
Bark from trunks 55 to 62 years old	2.30	1.52

3. The quantities of green bark which a cubic meter of each class of products yields *decreases rapidly* as the age increases. The difference is less rapid in bark dried in the forest; and, as will be further shown, young bark loses relatively more water than that which is old. The justice of this conclusion will appear from the following statement:[2]

	Green bark.	Bark dried in the forest.
	Quintals.	*Quintals.*
"Glossy bark" from branches of coppice	6.32	3.20
"Average bark" from branches of full grown trees	5.46	3.02
Bark from trunks 16 years old	5.12	2.64
Bark from trunks 24 years old	5.02	2.78
Bark from trunks 38 years old	4.62	2.76
Bark from trunks 55 to 62 years old	2.94	2.00

4. If we take into account the quantity of bark produced, as compared with the whole amount of oak wood of all kinds (some of which is not peelable), the production of bark will remain almost constant for different ages.

A cubic meter of wood of all kinds yields as follows:

	Green bark.	Bark dried in the forest.
	Quintals.	*Quintals.*
Bark from coppices 16 years old	3.80	2.00
Bark from coppices 24 years old	3.84	2.12
Bark from coppices 38 years old	3.87	2.29
Bark from reserves 55 to 62 years old	3.32	2.10

[1] The *stère* has the same dimensions as the *cubic meter*, but is applied to articles like wood, which are piled so as to leave interstices between the pieces, while the latter is used to express the solid contents, no allowance for vacant places. It is also used in measuring charcoal.

[2] According to M. Bouvart the yield of dry bark is 103 kilograms for coppice 15 years old; 102 kilograms for that which is 20 years; 101 kilograms for 25 years, and 40 kilograms for trees 48 years old.

5. The yield per cent. of green bark from freshly-cut wood diminishes in proportion as the age increases, and it is the same from the foot of the trunk toward the top, because it contains—

Of "glossy bark," in the branches, 35 per cent. of the volume of freshly-cut wood.
Of "average bark," in the branches, 30 per cent. of volume.
Of "glossy bark," in the trunk, 27 per cent. of volume.
Of "average bark," in the trunk, 18 per cent. of volume.

It also results from all the experiments that have been made that the lower part of the trunk, from the soil to a point two or even three meters above, gives a much less per-cent. in volume of bark than that above this height.

6. The loss in weight on the amount of water withdrawn from bark by drying in a forest *diminishes* in proportion as the wood is of greater age, and, consequently, from the foot of the tree toward the top, as follows:

Of "glossy bark," of the branches, 49 per cent. in weight.
Of "average bark," of the branches, 45 per cent. in weight.
Of "glossy bark," of the trunk, 42 per cent. in weight.
Of "average bark," in the trunk, 32 per cent. in weight.

It also results from all experiments that the loss in weight in the lower part of the trunk, up to 2 meters in height, is a little less—about 13 per cent.—than that which occurs in the trunk at greater height.

7. Likewise the loss of volume which green bark suffers in drying in the forest is less for wood of greater age, and, as a consequence, it is less at the foot of the tree than at the top, it being as follows:

In "glossy bark" of the branches from a green state, 41 per cent.
In "average bark" of the branches from a green state, 36 per cent.
In "glossy bark" of the trunk in a green state, 34 per cent.
In "average bark" of the trunk in a green state, 21 per cent.

The decrease of percentage in volume is slightly less than the loss per cent. in weight. The difference is greater with bark taken from stems of less age than it is when taken from those that are older.

8. The volume is almost constant for a given weight of bark. It is always greater in bark dried in the forest than in green bark, and it also increases with the age of peelable wood.

One quintal of bark measures as follows in cubic meters:

	Green bark.	Bark dried in the forests.
Glossy bark from the branches	0.0550	0.0640
Average bark from the branches	0.0550	0.0630
Bark from trunks 16 years old	0.0535	0.0615
Bark from trunks 24 years old	0.0552	0.0635
Bark from trunks 38 years old	0.0587	0.0667
Bark from trunks 55 to 62 years old	0.0625	0.0715

For this purpose it would be convenient to employ reduction-tables for converting cubic meters into the corresponding weight of "glossy" or "average" bark, as well as green bark, into bark that was forest-dried.

9. In comparing the peelable wood of the trunk with that of the branches, as also the bark yielded by the stem with that from the branches, we get different results, according as it may be "glossy" or "average" bark.

To 100 stères of oak yielding "glossy bark" in the trunk we have 10.8 stères of peelable wood in the branches.

To 100 stères yielding "average bark" we have 57.5 stères of peelable wood in the branches.

To 100 cubic meters of oak yielding "glossy bark" in the trunk we have 4.9 cubic meters of peelable wood in the branches.

To 100 cubic meters yielding "average bark" in the trunk we have 33 cubic meters of peelable wood in the branches.

To 100 kilometers of green "glossy bark" from the trunk we have 6.4 kilometers in the branches.

To 100 kilograms of green "average bark" from the trunk we have 61 kilograms in the branches.

To 100 kilograms of "glossy bark" from the trunk, dried in the forest, we have 5.5 kilograms in the branches.

To 100 kilograms of "average bark" from the trunk, dried in the forest, we have 50 kilograms in the branches.

10. The specific weight of green oak wood not peeled is generally uniform in young plantations. But in older trees it varies between 0.94 to 1.00; but the specific weight

of the lower parts of the trunk (up to 3 meters from the ground) is always greater than it is above.

11. The specific weight of green wood peeled, is always greater than when the bark is on, and varies between 0.97 and 1.04, and the specific weight of the wood alone is always greater near the ground than it is higher up.

12. Green bark is always lighter than green wood. The specific weight of green bark diminishes in proportion as the tree grows older.

13. Bark dried in the forest is naturally specifically lighter than green bark, and this also diminishes as the tree grows older. The facts stated in paragraphs 12 and 13 are shown as follows:

	Specific weight.	
	Green bark.	Bark dried in the forest.
Glossy bark from the branches	0.911	0.784
Average bark from the branches	0.910	0.790
Glossy bark from trees 16 years old	0.934	0.815
Glossy bark from trees 24 years old	0.905	0.768
Glossy bark from trees 38 years old	0.849	0.749
Glossy bark from trees 55 to 62 years old	0.807	0.699

Although the above experiments upon bark in its green state, or dried in the forest, are of most importance, we should not neglect the conditions of bark dried in the open air, and for this end the process was conducted as follows:

From the various kinds of bark used in the preceding experiments, there was weighed from six to eight kilograms that had been dried in the forest, and its volume was ascertained. Each of the specimens, carefully labeled, were then collected and sent in a sack to Hohenheim, and there kept from the end of May, 1874, to the end of April, 1875, in a small house, upon planks, perfectly dry, and well exposed to the air. When completely dry they were again weighed, piece by piece, on a warm, dry day, with bright sunlight, and their value was ascertained with great exactness by a xylometer. The results may be easily stated in a few points:

1. Both "glossy" and "average" bark from the trunk lost, in passing from forest-dried to exposure in open air, 4 per cent., and from the branches 5 per cent., of water. This is further shown in the first column of the next table.

2. The change in volume in passing from the condition of forest-dried to drying in the free air was much greater, while from green to forest-dried the percentage lost by g een bark was much more than the relative loss of volume, the results being opposite. The difference which for forest-dried bark exists between the loss of weight and loss of volume was found to be sufficiently compensated in its further drying in free air, so that for the latter the volume agrees approximately with the percentage of weight lost by evaporation. It disappears, in fact, in its passage from forest-dried to full drying, the amount being shown in the second column of the following table:

	Loss from green to full drying in open air.	Loss of volume in passing from forest-dried to full drying.	Total loss of volume from green to full drying.
	Per cent.	*Per cent*	*Per cent.*
For glossy bark from the trunk	46	11	51
For average bark from the trunk	36	11	32
For glossy bark from the branches	54	19	60
For average bark from the branches	50	20	56

3. The specific weight of the older "glossy bark" from the trunk (38 years), dried in the free air, agrees very nearly with that dried in the forest (0.74, instead of 0.75), but young "glossy bark," on the contrary, has a little greater density, it being 0.80 per cent. at the age of 24 years, 0.86 per cent. at 16 years, and 0.83 for branches. In like

manner, "average bark" dried in the free air agrees almost with that dried in the forest, it being 0.69 for the trunk and 0.78 for the branches.

4. The volume of a given weight of bark dried in the free air scarcely differs from that dried in the forest, a quintal having the following contents in cubic meters:

	Green bark.	Bark dried in forest.	Bark dried in air.
Glossy bark from branches	0.0550	0.0640	0.0610
Average bark from branches	0.0550	0.0630	0.0620
Bark from trees 16 years old	0.0535	0.0615	0.0575
Bark from trees 24 years old	0.0552	0.0635	0.0635
Bark from trees 38 years old	0.0587	0.0667	0.0675
Bark from trees 55 to 62 years old	0.0625	0.0715	0.0725

THE SUMAC AS A MATERIAL FOR TANNING.

Next after the oak and hemlock, we should mention the sumac, of which several species of the *Rhus*, but chiefly the *R. glabra* and *R. tyhina*, afford with us the principal supplies.

The sumac best suited for tanning and dyeing purposes grows wild in a belt of country extending from Maryland, down through the Atlantic States to Georgia, and through Alabama, Mississippi, Louisiana, and Texas, and in portions of Kentucky and Tennessee. The northern climate appears too cool for developing the tanning properties of this plant to the best advantage, although large quantities of the leaves gathered in Pennsylvania and New York are sold to the tanners of goat-skins, who put it in vats to strengthen up and keep the sewed skins from leaking, and it is used by many tanners to brighten the color of their leather.

The State of Virginia at present takes the lead in the production of sumac, and the business of collecting, grinding, and packing is carried on at Richmond, Fredericksburg, Alexandria, Culpeper, Winchester, and perhaps other places. The season for picking begins about the first of July and ends the last of September, or with the first frost, for when the leaves turn red in autumn, they are no longer of value. The tanning properties of the sumac reside in the leaves, and only these should be gathered, and the difference of value in this article is found often to depend very much upon the care with which the leaves are gathered and dried. The blossoms and berries, as well as the stems, should be thrown out. It should be dried in the shade. When cured, it is taken to the mills and ground by being placed under heavy wooden wheels, rolling in circles, at the ends of axles attached to a revolving shaft. These grinding-wheels are inclosed in a close covering to keep in the abundant dust that rises. Those used in Virginia are somewhat expensive, but in Sicily they grind the leaves in a very primitive manner under stone wheels on a stone bed.

CULTIVATION OF THE CORK-TREE IN THE UNITED STATES.

In 1858, and, it is believed, at an earlier period, quantities of acorns from the cork-oak were procured from the south of Spain, and distributed from the Patent Office to those sections of the country where it was thought they would thrive. A report made at the close of 1875, from Winnsborough, S. C., shows that all the acorns planted in 1859

came up and made healthy plants. Three of these are now about twenty-four feet high and over 27 inches in circumference. Two trees, at least, are flourishing at Orangeburg, S. C., and there are probably elsewhere in the South examples of successful planting of this tree. The cork-oak requires a warm climate; but the Southern States and California appear perfectly well adapted to its wants. The leaves are evergreen, like the live-oak, and it is of slow growth. An acorn of the cork-oak, planted in 1862, at Santa Barbara, Cal., has grown to about twenty feet in height, and covers more than this breadth of ground. At one foot from the ground it measures 40 inches in girth, and at 6 feet, where its branches begin, it is 30 inches. The bark of this tree is an inch and a half thick, and the cork apparently of the best quality.[1]

In its native countries the cork-tree is peeled once in eight or ten years, beginning when 25 or 30 years old, and care is taken not to injure the inner bark. A new layer of cork forms readily, and the tree seems to thrive under the treatment, and lives to a great age. The importance of cork as an article of commerce will be seen from the following tables. The unmanufactured article has since 1871 been imported free of duties. Upon manufactured cork the duty is now 30 per cent. *ad valorem.*

Importation of cork (unmanufactured) in recent years.

Years.	Value.	Duties (30 per cent).	Years.	Value.	
1869–'70	$297,907 41	$62,372 22	1872–'73	$645,928 00	
1870–'71	92,971 44	27,891 44	1873–'74	435,270 00	
	266,644 97	Free.	1874–'75	383,005 00	
1871–'72	484,348 04	"	1875–'76	606,169 00	

Importation of manufactured corks in recent years.

Years.	Value.	Duites (50 per cent).	Years.	Value.	Duties (30 per cent).
1869–'70	$171,849 92	$85,924 96	1872–'73	$154,269 88	$46,280 96
1870–'71	144,578 08	72,289 05	1873–'74	115,727 23	34,718 16
1871–'72	125,480 33	62,740 19	1874–'75	103,335 86	31,000 75
1872–'73	5,333 00	2,666 50	1875–'76	74,394 90	22,318 47

LEAVES FOR FORAGE.

In Europe, the leaves of trees, more especially of the ash, form an important article of forage for domestic animals in winter. With us, in the new settlements, a pioneer's team and little group of domestic animals have often been helped through the first winter in the wilderness by "browzing;" but it may be doubted whether the American farmer will ever gather leaves from the woods as an article of fodder for his stock, nor will he, if he understands their value in the formation of humus and fertilization of the soil, allow them to be wasted or burned.

FORESTS AS A SHELTER FOR GAME.

This use of forests, which formed the earliest, and in some cases still forms a principal reason for their preservation, implies a privileged class which does not exist among us; and hence there is little probability that this feature of forest management will ever assume in this country

[1] *Santa Barbara Weekly Press,* January 27, 1877.

any importance beyond what may incidentally relate to city parks and limited tracts that may be owned by associations of sportsmen. The term "*Forst und Jagd*" (forest and hunting) is inseparably connected with German forest literature and law, and the care and feeding of game is a regular branch of education in the forest schools of that country. The government derives some revenue from the sale of hunting licenses.[1]

DAMAGES FROM FOREST FIRES.

The losses resulting from running fires are within the observation of all, as no district of considerable extent in the country has been entirely free from them, and in very many places their effects are sadly apparent in the blackened trunks of dead trees, and the prevalence of a younger growth of rapidly-growing but inferior kinds of timber in the place of forests that were in full maturity and of great value. One of the theories accounting for the prairies, ascribes them to the fires annually set by Indians[2] for driving game, or for favoring the growth of grass that should attract deer and other game to this pasturage; and so far as relates to "oak openings," "barrens," and the prairies east of the Mississippi, this theory has the strongest ground of probability. However this may be, we have these facts before us, that scarcely a year passes without the occurrence of forest fires of sufficient extent to attract public notice; that they are particularly prevalent in seasons of protracted drought, and more frequent from year to year as these droughts become more frequent and more widespread in their effect. It may be well to notice some of these cases of destruction, and some of the means by which it has been proposed to prevent their recurrence.

Fires occur more or less extensively among the timber in the mountain regions of the Territories, and some of these have proved exceedingly destructive. Early in 1860 and in 1862, fires of unusual extent and severity overran portions of the country westward from Laramie plains, now Wyoming Territory, spreading with such fearful rapidity that neither man nor wild beasts could escape, and burning not only the timber, but the turf and vegetable matter in the soil. Seedling-pines sprang up in parts of this burnt district in great abundance, with a mixture of cottonwood and other species, but so dense that a large number died out when three or four years old.

The summer and autumn of 1871 were unusually dry, with prevailing southwesterly winds, the rain-fall being less, and the evaporation more, than the general annual average. These conditions favored the spread of forest fires in the Rocky Mountain region, and throughout the Northwestern States, which will long be remembered, like the Chicago fire of the same year, for their extreme severity and great extent. The fires in Wisconsin and Michigan were altogether unprecedented, and swept not only through forests but even cultivated farms and through villages, taking everything in their course. Including the surface overrun in the prairie region as well as in forests, the area swept by the flames in that year must have been many thousands of square miles.[3] The pecuniary loss no one has ever been able to estimate, as no data were collected. It

[1] In 1851–'52 there were 87,235 licenses sold; in 1856 there were 91,491, the increase being about the same as that of the population. The percentage of hunters was 0.478, or about 1.76 per cent. of the males over 20 years of age.

[2] In British India the hill people have a tradition that the burning of forests has a salutary effect. This is kept alive by actual experience of the increased healthfulness of the districts after fires.—(*Indian Forester*, ii p. 271.)

[3] Paper by Prof. I. A. Lapham. *Report of Chief Signal-Officer, War Department*, 1872, p. 186.

must have amounted to hundreds of millions of dollars. All accounts agree in stating that a dry and strong southwest wind contributed to the spread of the flames, and, so far as we have records, the percentage of moisture was extremely low.[1]

The forests in Northeastern Pennsylvania were ravaged by fires in the fall of 1876, and the mountains of Delaware and Sullivan Counties, New York, have been repeatedly burnt over in recent years. A dry, sandy region on the eastern border of Lewis County and the "pine plains" of Jefferson County, New York, have been, time and again, overrun with fires. In other sections, once covered with pine forest, the timber is now replaced by ferns, huckleberry, and blackberry bushes, which the calcined soil is scarcely able to support, but which may in a long course of years, if not again burnt over, bring fertility back in sufficient amount to bear trees of some value.

A fire got started in the woods May 14, 1877, near Clinton Mills, Clinton County, New York, which consumed several lumbering-villages and establishments, and burnt over a large area of forest, destroying standing timber beyond means of computation, besides a very large amount in lumber and other property. Extensive fires prevailed the same season in the woods of Vermont, New Hampshire, and Massachusetts, and in Canada, Wisconsin, and the upper peninsula of Michigan.

New Jersey has suffered from forest fires, especially on the Blue Mountain, in the extreme northwest, and throughout a wide region of pine woods bounded on the north by Metedeconk Creek, south by Denin's Creek, and west by the marl line. This region extending to the coast, and comprising a million or more of acres, having been stripped of wood for charcoal, has repeatedly been the scene of destructive fires, increasing within the past few years in extent of damage, a single fire sometimes running over thousands of acres. In 1866 one swept over 10,000 acres; the burnt district reaching from Tuckerton to West Creek, a distance of seven miles westward. In 1870–'71 nearly the whole wooded portion of Bass Township, Burlington County, was burnt over. In 1871 two fires in Ocean County burned over 30,000 acres, and the whole county is overrun about once in 20 years by fire. In 1872, owing to the long drought in summer and autumn, fires were frequent in Southern New Jersey, one in August burning from 15 to 20 square miles, worth, before the fire, from $10 to $30, and after it from $2 to $4 per acre. These risks have reduced the salability of woodlands to a very great extent. These fires were formerly started generally from coalings on brush burning, but latterly for the most part by locomotives, which have done the greatest damage.[2]

On account of these fires so frequently running over this part of the State, there is but little large timber, although more than nine-tenths of the surface is wooded; and the residents are obliged to import nearly all the lumber required for use. Ship-building has been almost entirely abandoned, and the products of the forests may be said to be cord-wood and charcoal, instead of timber for construction and use in the arts. Worse than this, the vegetable mold in the soil is burned out, and the possibility of reproduction reduced to narrowest limits, or altogether

---

[1] Some estimates placed the loss by fires in 1871, equal to the ordinary consumption of the country for ten years.

[2] There is also a growing belief that some have been set by wood-choppers and charcoal-burners to make business for themselves, in coaling the wood which otherwise would be allowed to remain for the more valuable lumber of older growths. In many cases it is not actual incendiarism, but carelessness, perhaps intentional, that in this way gives additional work to these people.—(*Report of the New Jersey State Board of Agriculture*, 1874, i, 60, from which most of the above facts are derived.)

prevented. Moreover, the climate has been injuriously affected, and droughts are much more common than formerly, owing to the dry and parched nature of the whole country thus stripped of its vegetable covering, and left as a "blackened desert."

In an article by Charles E. Elmer, of Bridgeton, N. J., in the report above cited, some facts and suggestions are given that are worthy of notice. He says:

The year 1872 is noted, the country over, for the extent and destruction of timberland by fires. True it is that the extent of burning was principally owing to the remarkably continued dry weather from early spring until early fall. I have endeavored to ascertain, measurably, the great loss by these frequent and destructive fires, but without success. To assert that 100,000 acres have been burnt over within the State of New Jersey, at a money loss in timber of $1,000,000, would surely be within the bounds of truth. These fires have been occasioned by the careless use (I say careless, when no consideration was given to the great drought and the remarkably dry condition of the soil, and of all things lying thereon,) of what is called *firing* to burn sedge upon old fields and *brush* upon new clearings. From these causes much waste of valuable timber has been made, the escape fire extending for many miles, when under ordinary circumstances it would have been limited to a few rods.

The damage occasioned by sparks from locomotives has been almost beyond computation, as to the extent of acres and loss of timber, which under the average moisture of the atmosphere and soil could hardly have occurred at all. These relations are facts known to all men, and likely to occur again under like combination of circumstances. Now, as to a remedy to be had by force of law.

It has been and is held as law in England that fire communicated by a passing engine is *prima facie* proof of negligence in its use, and the onus is placed on the company to show that there has been no negligence; that the engine was in proper order, properly run; had all known appliances to prevent fire from escaping, and that the track of the road was alike guarded. And this upon the ground that fire being a dangerous element the legal responsibility is placed upon those using it to the damage of others to show that all and every proper precaution and care was had in its use. Upon the same principle, if a man uses a dangerous article upon his own land, he is bound, at his peril, to keep it there, and cannot be excused for its escape, unless it be by the act of God or some overpowering force. In this country this strict ruling has been greatly relaxed, although it may be true yet that, in some of the States, railroads, as also persons (for the same rule must hold good as to both), are held to the strict English rule.

In some other States, as in our own, I think it is determined that the railroads are not responsible for a communicated fire, while doing the lawful act of running their engines, unless guilty of "negligence or folly," and the burden of proof is on the plaintiff to show the negligence; and directing that, with due diligence and proper care, a railroad is not otherwise liable for communicating fire than as an individual is for firing his neighbor's property by an accidental spark from his chimney. What constitutes this "negligence and folly" is for the determination of a jury, each case depending upon the facts educed in evidence, and ofttimes upon the favorable or unfavorable standing of the railroad in the community in which the trial is had.

Another vexatious question, troublesome alike to the courts and railroads, is, how far the liability extends, even in case of negligence; whether only the person immediately damaged, or those damaged beyond, so far as the fire shall extend? They say the damage beyond the immediate firing is too remote to hold them to account. Upon this our own courts have not formally passed. * * * How can there be a preventive had against such losses as have occurred from fire in 1872, under like circumstances of great and continued drought, by the rulings of courts or by statutory provisions? The great railroad highways for passage and freight, extending all over the United States, have revolutionized society and business, making rich the people thereof, and increasing in value each acre of land through or near which the iron highway runs. If by law you require them to run their engines with smoke-stacks so constructed so that no spark shall escape, then you diminish the speed unreasonably asked for by travelers, at great risk of life, and you in a great measure destroy the motive-power by removing the necessary draught. If, by law you hold them to the strict English rule, that any firing is *prima facie* evidence of negligence, and put the onus of proof on them, and, in addition, hold them to answer for all damages, however remote from the origin of the fire, and abolish the rule of law that where the injury is the result of concurrent negligence in both plaintiff and defendant, no suit can be maintained—as might be held to be the case where the owner allows the dry brush and leaves to accumulate in the woods beside the railroad track—might it not work ruin to those companies which are doing so much to build up and enrich the country? I grant that many of these companies are becoming too powerful and perhaps dangerous in the use

of their strength, and need surely very much restraint; but we are now considering additional legislation to guard against losses by fire occasioned by them in the practice of their lawful business, and I confess that I cannot suggest any other than those hinted at above, and must admit that the propriety of them may be questionable, and may not be effective to that end.

The Commissioner of Crown-Lands in the province of Quebec, in his report of 1871, speaking of the precautions necessary for the preservation of timber-lands, says:

The most formidable agent in the destruction of our forests is, certainly, *fire*. All the most active operations in lumbering which have taken place since the settlement of the country, and all those which are likely to take place for the next twenty years, have not caused and will not cause to our forests so much devastation as this one destroying element has effected up to the present time.

In a report on forestry and forests of Canada, by H. G. Jolly, member of the Dominion Council of Agriculture,[1] it is estimated that *more pine-timber has been destroyed by fire than has been cut down and taken out by the lumbermen*, the injury extending as well to the young trees, upon which future supplies must depend, as to the timber already mature. After enumerating the means employed in Europe for extinguishing forest-fires, such as calling out a large population by alarm-bells, and directing their labors, under the guidance of acknowledged leaders, the maintenance of *safety-strips*, or clear spaces through the forests, and other means of defense against spreading fires, he justly remarks that none of these can be applied extensively in this country, and that our main dependence must be upon PREVENTION.

CANADIAN LEGISLATION IN RELATION TO FOREST-FIRES.

The following is a synopsis of an act of the legislature of Quebec, assented to December 24, 1870, respecting the clearing of lands and the protection of forests against fires:

1. No standing tree, shrub, or other plant in any forest, or within a mile of a forest, is to be set fire to at any time.

2. No pile of wood, branches, or brushwood, or fallen trees, turf, peat, stumps, or fallen timber is to be set on fire in a forest, or within a mile, except for clearing land, and then only between September 1 and July 1.

Notwithstanding the above provisions, fires may be made in or near a forest to obtain warmth, or to cook, or for industrial purposes, as the making of tar, turpentine, charcoal, ashes, &c., but if between May 15 and October 15, with the following conditions. The person making the fire must—

1. Select a place where there is the least quantity of vegetable matter, dead wood, branches, brush, dry leaves, or resinous trees.

2. Clean the place of all vegetable matter within a radius of 25 feet, if for the industries, or within 4 feet as regards fires for warmth or cooking.

3. Totally extinguishing the fire before leaving the place.

No person is allowed to drop or throw down a burning match, ashes of a pipe, cigars, wadding of fire-arms, or other burning substances, without extinguishing the fire at once. The penalty prescribed is a fine of $50 and costs, or imprisonment not over three months. Prosecution to be begun within three months, and one-half of the fine to go to the prosecutor. Any justice of the peace, himself viewing the act, may impose the penalty without further proof, and all employés of the department of crown-lands, land-surveyors, and wood-rangers in the employment of the crown-lands, were declared *ex-officio* justices of the peace for the purposes of this act.

PRECAUTIONS AGAINST INJURY FROM FIRE ALONG RAILROADS, AND OTHERWISE.

The frequent occurrence of forest-fires along railroad-lines, and great losses that occur from the burning of property from this cause, leads us

[1] *Report of the Minister of Agriculture* for 1877. Appendix i, p. 1 to 20.

to consider the measures available for their prevention. Among these may be suggested the following:

1. Vigilant watching, and an extra number of watchmen in an exceptionally dry time, with suitable provision of water where there is great probability of its being needed.
2. Arrangements for notifying by telegraph, and for bringing by railroad, a sufficient amount of aid, in case of dangerous forest-fires.
3. The clearing away of litter and other combustible materials, or the entire clearing of woodlands in the immediate vicinity of the track, with the view of lessening the danger from fire.
4. Planting safety-belts, as in Europe, where a strip of birch is set on each side of a railroad-track, where it passes through a pine forest.
5. The careful burning off of dry grass, piles of decayed ties, and other inflammable material, at a season when the fire would not be apt to escape, and with a sufficient force at hand to prevent this accident.
6. In improved construction of locomotives, to prevent danger from sparks, and if this implies less speed, from reduction of draught—a modification of time-tables to suit this arrangement, at least through the dangerous season.

A law making a man liable for damages caused to others by fires that he has kindled would be of service so far as it enforced caution upon owners of property, but something more would be needed in the way of personal punishment with those who have nothing to lose. The only remedy would be a law declaring the act of setting fire to woods a crime punishable by fine or imprisonment, or both, according to the circumstances of the case.

In all of the States provision is made directly or indirectly for preventing the malicious firing of woods, by fines and penalties, but there is perhaps no one of these statutes but that might be improved by providing more strictly against the careless use of fire, and for their more speedy extinguishment when once started, by giving power to local magistrates for calling out the aid of citizens in case of great danger, which can now generally be done only by the voluntary act of individuals. Amendments are more especially needed to our laws that shall enforce caution, in the use of matches, in smoking, in hunting, in the building of camp-fires, in charcoal-making, and in clearing lands, and especially in regard to railroads, as hereinbefore specified.[1]

SPECIAL LEGISLATION IN FRANCE FOR PREVENTING FIRES IN FORESTS UNUSUALLY LIABLE TO CONFLAGRATION.

The repeated and disastrous fires in the region of Maures and l'Estérel, some 40 by 70 miles in extent, on the shores of the Mediterranean, between Nice and Marseilles, led the administration a few years since to make special investigations, with the view of finding the proper means

[1] In the colonial-land grants of New York it was not unusual to include in the patent restrictions upon the setting of forest-fires, and reservations of timber for the royal navy.

As an example of these restrictions, we will notice them as given in a patent for a tract north of the Mohawk River, granted to William Cosby, June 1, 1739. The grantees were not (or others by their privity, consent, or procurement) to "set on fire or burn the woods on the said lands, or any part thereof, so as to destroy, impair, or hinder the growth of any of the trees there that are or may be fit for masts, planks, knees, or other timber fit for the use of the royal navy."

This is however, not to hinder the grantees "from such burning of the woods, or cutting down or falling of the trees that are or shall be growing or being on the above-granted lands, or any part thereof, as shall be necessary or conducive to the clearing or effectually cultivating the same lands or any part thereof, or to or for their own uses. And we do hereby further declare that by the said burning of the woods is only meant and intended that our said grantees, their heirs and assigns, are to be restrained only from setting fire to and burning any timber or trees whilst they are standing and growing upon the above-granted lands or any part thereof."

for prevention. The wooded surface exposed to these fires, amounted to 111,331 hectares, mostly in the department of Var, of which 88,978 belonged to private owners, 21,402 to communes, and 7,951 to the State. The commission appointed for these inquiries sought to study the circumstances, discover the causes, and devise the remedies.

As the conditions were not unlike those that may be met with in this country, this matter becomes one of practical interest. The region possessed a rich soil, was exposed to an ardent sun, and was watered by abundant rains at a season most proper for giving exceptional vigor to forest vegetation, and, as a consequence, an abundant accumulation of litter. But it was also at certain seasons liable to protracted droughts, and then the least careless spark would start a fire which, in a strong wind, nothing could stop until the tinder upon the ground was burnt off. The forests were of the most valuable kinds—chestnut, cork-oak, and maritime pine—and suffered severely in these running fires.[1]

In studying the *causes*, the commission ascribed the least to malevolence; next, carelessness of hunters and smokers; and most to want of sufficient care in the use of fires set under the forms of "*taillades*,"[2] "*issarts*,"[3] and "*ecobuages*."[4] These practices belong to the traditions of an age of ignorance rather than to the precepts of enlightened forestry, which might be difficult to wholly prevent, but should be kept within the limits of safe control. Such rubbish must at times be disposed of, and the chief difficulty was to do it safely.

The remedies proposed consisted, first, in a modification of the code, imposing severe regulations in the use of fires, which were to be set only when licensed by the prefect upon the advice of proper authorities; next, in the construction of a net-work of roads and trenches, running through the forests in such a manner as to prevent the spreading of fires and to afford effectual lines of defense. These were to be kept at all times clear of combustible materials. The roads were to be from 20 to 50 meters wide, and boundary-lines between adjacent owners were to be thus kept open, half on each side of the line, and at their joint expense. A grant of 600,000 was made from the contingent fund of the ministry of finances, this being half the cost of constructing the net-work of cleared spaces through the forests, the remainder being paid by the owners. This special law was limited in its operation to twenty years, and was promulgated on the 27th of July, 1870.[5]

The French forest-code contains the following articles with respect to

---

[1] From 1838 to 1848, 40,000 hectares were burnt over, causing 4,000,000 francs loss. From 1848 to 1868, 25,000 hectares were ravaged, at a loss of 5,000,000 francs.

[2] The *Taillade* is a running fire set in a piece of land that has been wholly cut off, and the valuable woods removed. It much resembles the rude primitive way of clearing forest-lands in our own country, except that the wood worth taking is removed, leaving nothing but brush and rubbish on the ground. It was found so dangerous in the districts above mentioned that it had been mostly abandoned by the inhabitants.

[3] The *Issart* is a fire set in thin forests of old timber to burn the brush, brambles, and rubbish, which are first drawn away from the trees, arranged in lines, and partly covered with soil.

[4] *Ecobuage* is the practice of burning mosses, herbs, brambles, brush, and rubbish in rude kilns of earth, here and there in the woods. The object is partly to destroy the insects that harbor in this rubbish. The calcined dirt and ashes are then mixed and scattered over the surface.

[5] The motives of this law and reports made officially concerning it are given in the *Revue des Eaux et Forêts*, 1870, pp. 345–374. See also *Enquête sur les incendies des forêts dans la région des Maures et de l'Estérel. Paris*, 1869. Imperial Press.

the use of fires in or near forests, and the measures to be taken when they become dangerous:

ART. 148. It is forbidden to carry or kindle fire within woods or forests, or within 200 meters of the borders, under a penalty of 20 to 100 francs, besides the penalties provided in the penal code, and all rights for damages to private interests, if any occur.

ART. 149. All occupants who, in case of fire, refuse to bring aid in the woods under their rights of usage, shall be turned over to the correctional police and deprived of these rights for not less than one and not more than five years, and shall be further subject to the penalties mentioned in article 475 of the penal code.[1]

The official reports of Austrian forests for 1876 show that 170 fires had occurred in their woodlands during that year, of which the cause was accident in 46 cases, malice in 11, locomotive-sparks in 1, and unknown in 112. The area burnt was 841 hectares (2,077.7 acres), and the loss 17,181 florins in value.

INSECT RAVAGES.

These, at times, become the source of great injury to forests; some species commencing with the seed, and others appearing upon the plant at every stage of its growth, until its final decay is often thus caused, and almost always hastened when begun.

The damages to leaves are mostly caused by the larvæ of lepidopterous insects, especially the nocturnal moths and myriads of their caterpillars. Of borers, some mine into the heart wood, while others feed under the bark and upon the layer of new wood, and by spreading in their burrows they effectually girdle the trees that they attack. These borers belong to the coleopterous class, and the most extensive families are the Capricorn beetles, belonging to the Fabrican genera: *Prionus*, *Cerambyx*, *Lamia*, *Stenocorus*, *Leptura*, *Ragium*, *Gnoma*, *Saperda*, *Callidium*, and *Clitus*, and to others since described.

ENEMIES OF THE OAK.

M. Coutance, a French author, in his special treatise upon the oaks,[2] enumerates 98 species of insects that infest this tree, of which 49 belong to the coleoptera, 25 to the lepidoptera, 16 to the hymenoptera, 5 to the hemiptera, and 3 to the orthoptera. Of these, 18 attack the wood, chiefly coleoptera; 10 the bark, all of them coleoptera; 30 the leaves, of which 19 are lepidoptera and 10 coleoptera; 12 the leaves and wood, all of them coleoptera; 6 the fruit, of which 2 are hymenoptera and the rest coleoptera; 3 the flowers and fruit, all lepidoptera; 2 the young shoots, hymenoptera; 5 the petioles, 3 the buds, and 3 the twigs, all hymenoptera; 5 the twigs and petioles, hemiptera; and 1 the root, orthoptera.[3]

The oak also nourishes hundreds of species of cryptogamous plants, chiefly in its decline, and when dead and rotting. A few only of these injure its growing, chiefly as rust upon the leaves.

The evergreen oak (*Quercus ilex*) has suffered much in France from the ravages of the larvæ of a beetle (the *Coræbus bifasciatus*), which pierces the bark and bores galleries in the wood, or inner bark, and

[1] This article imposes a fine of 6 to 10 francs upon those who refuse or neglect to render aid when requested in case of accidents, * * * *fires*, or other calamities.

[2] *Histoire du Chêne dans l'antiquité et dans la nature; ses applications à l'Industrie aux Constructions navales, aux Sciences et aux Arts, etc. Par A. Coutance, Prof. d'Hist. Naturelle, à l'école de médecine navale de Brest.* Paris, 1873, pp. 558.

[3] A *Phylloxera* nearly allied to the species that has done so much injury to the vine in Europe has been found upon the oak, but not in sufficient numbers to prove particularly injurious. (*Revue des Eaux et Forêts,* 1874, p. 362.)

sometimes along the pith of the small branches, until ready for transformation, when it comes to the surface and becomes a perfect insect.[1]

INSECT INJURIES TO THE HICKORY.

An insect described by Thomas Say, in 1824, as the *Scolytus tetraspinosa*, a beetle, formerly limited to the region known in early days as "Missouri Territory," is reported as becoming abundant, both in the Eastern and Western States, and as particularly injurious to the hickory. In a paper read before the New York Academy of Sciences, June 4, 1877, by Mr. Andrew S. Fuller, the following facts are stated concerning this insect:

It is quite a minute beetle, a little over a fifth of an inch long; color black; elytra brown; antennæ pale rufous; thorax punctured, black-brown; elytra reddish-brown, truncated with inpunctured striæ, and an obsolete series of punctures on the interstitial lines; tip denticulated; venter obliquely truncated, the posterior portion of the body appearing to have been cut off from the top of the elytra obliquely forward.

The sexes appear late in summer, and after copulating the males soon disappear. The female bores through the bark to the wood and lengthwise of the grain about an inch, the furrow being partly in the sap-wood and partly in the bark, and is about a sixteenth of an inch in diameter. Along each of the sides of this burrow she lays from 20 to 40 eggs. The grubs on hatching begin to burrow across the grain, feeding upon the young layer of fresh wood till cold weather, when they become dormant till spring. Then digging outward to near the surface they pass through the pupa state, and the perfect insect finally emerges. The insect begins its ravages near the top of the tree, or on the upper part of the stem, and gradually works downward from year to year. No effectual remedy is known.

THE BLACK SPRUCE AND ITS ENEMIES.

Prof. Charles H. Peck, of the State Cabinet, at Albany, New York, in an article read before the Albany Institute, May 4, 1875, on the black spruce of the great northern forest of New York, mentions the occasional occurrence of deep fissures, sometimes extending into the heart

---

[1] From a table given in an article in the *Revue des Eaux et Forêts* for April, 1876, it appears that certain forests of oak in the south of France, 10,425 hectares in extent, had 2,792 hectares, on nearly a quarter of the area, destroyed in 1876, leaving dead timber of paratively small value to represent a promising and valuable plantation. These injuries had recurred with some periodicity from time immemorial, the warmer regions being noticed as more liable to suffer.

Mr. Trégomain, the author of the article cited, notices that timber 20 to 25 years old was more liable to attack than that from 10 to 20. As to period of return, this appeared to depend upon circumstances that favored multiplication, and therefore to be a climatic question, rather than one incident to insect life.

It was noticed that the preceding winter, in the case above mentioned, had been unusually mild, with no snow and no prolonged frosts, a condition that was thought to favor the multiplication of this insect.

The writer of the article in the journal above cited, in speaking of the remedies possible, and to some extent within the agency of man, says:

"According to my observation, the true effectual means of prevention, is the preservation of insectivorous birds. It is here proper to notice the utility of the decree of the prefect of Gard, dated December 18, 1866, forbidding the taking or destroying of the eggs and broods of any kind of birds not declared injurious. But unfortunately this wise provision is but a dead letter; the field-guards, upon whom its execution chiefly depended, appearing not to know or not to care about its observance, * * * and agricultural societies would do well to offer prizes in money, in amount proportioned to the number of prosecutions had, for violations of this ordinance."

The *Eucaylyptus globulus* in Australia, has been often attacked by coleopterous insects, and in New South Wales, entire forests, covering thousands of acres, are completely dried up. This was attributed by some to drought, by others to inundations, and by others to a little fungus, which, in rainy seasons, appeared in abundance. Mr. William Wools, of Parramatta, a botanist who had given especial attention to the subject, had found no traces of this parasite, but had often seen the young eucalyptus trees infested with the *Coccus* and *Cladosporium*.—(*Sydney Morning Herald.*)

of the tree, and following the grain of the wood through a considerable part of its length. Perhaps not more than two or three per cent. were thus affected, and of the several causes suggested to account for this injury, such as frost, winds, lightning, &c., none are quite satisfactory. Of parasites of the black spruce he mentions the following:

Arceuthobium pusillum,[1] a phænogamous plant without true leaves, and botanically related to the mistletoe. It fringes the younger internodes of the living branches of trees growing in swamps and around sphagnous marshes. It is not positively known to kill the tree, but it probably sometimes does so.

Peridermium decolorans, a fungus in the leaves, which rupture and reveal a mass of yellow dust-like spores. Not common, occurring on starved spruces in the Adirondack region. Appears to attack degenerate and feeble trees.

The spruce is sometimes affected by a small plant-louse, which attacks the tips of the branches, and causes a transformation resembling green cones. It is closely related to the *Adelges coccineus* of Ratzburg and *A. strobilius* of Kaltenbach. It is found in abundance in Maine and elsewhere, but does not appear to cause serious injury.

The spruce is also liable to attack from other insects, the most serious injury being from an insect known as the *Hylurgus rufipennis* (Kirby), which, beginning near the ground and extending upward, perforates the bark and burrows under its inner layers until it entirely kills the tree, and sometimes whole forests. These insect ravages were experienced some thirty years or more ago in Rensselaer County, New York, and in recent years in the wilderness of Northern New York. Trees less than 10 inches in diameter are seldom attacked, and as these mining beetles usually prefer dead timber, it is possible that the trees affected may have passed the vigor of life and begun to decline in vital powers.

It has been noticed that timber growing upon high lands is more injured than in valleys, and that after prevailing for a few years the injury would cease, while an abundance of trees remained still intact. It has been suggested by Professor Peck that the woodpeckers, attracted by an abundance of dainty food within easy reach of their sharp beaks and barbed tongues, may have congregated in flocks sufficient to exterminate for the time being this excess of insect life, and restore the balance of nature. The abundant indications of their labors on the bark of the trees proved that they had been busy in great numbers, although flocks of these birds were not actually seen at their labors.

The pecuniary loss resulting from these insects has in some instances been considerable. Although the timber itself is not injured if cut soon after it is killed, the amount thus thrown upon the lumberman's hands is sometimes in excess of the wants of the market, and altogether beyond his means for using. An effectual remedy, so far as it can be seasonably applied, would be to cut down the trees first affected, as soon as the insects first appeared, and peel and burn the bark. The same class of beetles is almost sure of burrowing under the bark of sound logs when cut, if allowed to lie some time without sawing, and a better way in handling spruce timber is to peel off the bark as soon as it is cut, thus effectually preventing the injury to which it might otherwise be liable.

The spruce, in common with other evergreens, has at times appeared to have suffered from climatic vicissitudes, as in Northern New York, and in portions of New England, in the winter of 1871–'72. The mortality was by some ascribed to autumnal drought, followed by severe and protracted frosts, which appears in the case of the spruce to have impaired the vital forces and invited the attack of the *Hylurgus*, which had not been observed in those regions within many years before.[2]

---

[1] Botanical description given in Twenty-fifth Report on the New York Museum of Natural History, 1872, p. 69. See also Professor Peck's article on the black spruce, above cited, p. 12.

[2] The reports of Professor Peck, as botanist of the New York State Museum of Natural History, published in the Twenty-seventh Annual Report, p. 75, and the Twenty-eighth Report, p. 32, contain much information upon this subject. The bombyx or lasiocamp of the pine has been abunadnt within a few years in the pineries of Northern Germany. By this cause, within a period of ten years, 41,642 hectares of pine have been invaded and 10,244 completely killed, 8,654 half spoilt, and 22,794 badly injured. Hence 22,015,859 cubic meters have been prematurely worked, at a depreciation of about $168,980. The sum of $329,800 had been spent in remedies of various kinds.

DESTRUCTION OF PINE FORESTS.

The bulletin of the Superior Council of Agriculture of Belgium for 1875 (published in 1877) notices the deplorable condition to which large tracts of evergreen forest, planted on poor lands of the north, had been reduced through the ravages of an insect eating the leaves and thus destroying the trees, and gives a careful description of its habits and of the remedies that had been tried to prevent further injuries. This insect was a fly (*Lophyrus pini*) that produces two generations in a year, and the damage is done by its larvæ. The cocoon spends the winter among the mosses and litter near the foot of the trees, and appears as a perfect insect in the first warm days of April, or perhaps as early as March. The insects pair, and the female, which is rather sluggish in its flight, does not go far, but circles around the branches, and deposits her eggs, ten to twenty in a leaf, and usually several leaves in a group are thus attacked. The young larvæ begin to eat the parenchyma of the leaves, leaving the more solid portions, and, by their multitudes, stripping the trees of their verdure. They retire about the first of July into their cocoons, and in a few days a second generation appears, which renews its ravages in August and September.

The means attempted for their destruction are as follows:

1. Surrounding a woodland infected by these insects with a ditch, partly to isolate them and partly for the capture of the worms, but the latter is of little account, because they generally spend their lives in the same place, unless in vast numbers, when they are forced to emigrate by passing from one mass of timber to another. The ditch may be twelve or fifteen inches wide and of the same depth. A pit should be dug deeper than this every six or seven meters, for burying the worms as they accumulate in the ditch.

2. In young plantations, the worms may be shaken off by striking the trees and catching in cloths stretched under them. A man to shake the trees, and two lads to spread the cloths can before nine o'clock, go through more than half an acre, where the trees are fifteen to twenty years old. If the weather is not fair, they can work all day, and even in fair weather many are thus caught. Some have proposed to scatter branches under the trees, upon which the worms would crawl, and then they might be gathered and destroyed, but the cloths are much better and cost less time. Others take the worms directly from the trees, at an early stage of their growth, and while in masses, in June or September, by breaking off the branches or shaking off the worms into a basket. Some use scissors for cutting off the infected branches, and one man by this means had in one season destroyed over nine millions of worms. It is estimated that a man can kill from fifteen thousand to fifty thousand a day, counting the average number in the families at fifty each.

3. Gathering the cocoons in winter, as they are hid in the mosses and litter, by removing these materials; but this is deemed injurious to the soil, although they may be used as fertilizers in fields. In doing this, however, we destroy the eggs of many insects even more injurious than the *Lophyrus*.

4. In old forests, that have come to maturity, the foot of the trees may be banked with dry sand, by which the larvæ are hindered from coming out. A little may be done by turning in cattle that trample the ground and destroy the cocoons; but this is of not much account. Swine, so useful in killing smooth-bodied worms, do not have an effect in this case, as they will not eat them.

5. *Natural enemies.* These worms are very sensitive to atmospheric changes, such as cold, wind, and rain, especially at the time of molting, when many perish. They are sought with avidity by birds and mice, and squirrels kill many in winter. Several of the coleoptera attack them, and they, besides, nourish a great number of ichneumon parasites.

A general decay of the pine woods of South Carolina began in 1802, and the fact became a subject of careful inquiry among the naturalists and observers of that day. Mr. J. Mease, in a letter to Judge Peters, of Philadelphia,[1] attributes this decay to an insect, which was first ob-

[1] Very considerable injury has been done by these insects to the pines of South Carolina. In one place, viz, on the Sampit Creek, near Georgetown, in a tract of 2,000 acres of pine land, it has been calculated that 90 trees in every 100 have been destroyed by this pernicious insect. The adjoining lands, and many tracts on the Santee and Black Rivers, have equally suffered.—*Memoirs of the Philadelphia Society for Promotion of Agriculture*, 1815, i, 41.

served, at about the time above mentioned, in the northern and eastern parts of the State. It is described as "a small black-winged bug, resembling the weevil, but somewhat larger." A great number of these bugs have been observed in the spring of the year, and in the early summer, flying near the roots of the trees. They pierce the bark a little distance above the ground, and lay their eggs between the bark and wood; and in a few weeks after these eggs hatch, and a worm appears, which at its full growth is about an inch long. They immediately begin to feed on the sappy parts of the tree, and do not cease eating until the whole of it is destroyed.

BEETLES IN DEAD EVERGREENS.

It must have been noticed by every casual observer in the saw-mill-yard, that logs of evergreen species, as the spruce, hemlock, and pine, if allowed to lie a year or two with the bark on, suffer more or less, and often very seriously, from the ravages of insects, more particularly of the coleoptera or beetle class, which, entering at the end, burrow under the bark and into the sap-wood, which they perforate and destroy for every useful purpose, if allowed full opportunity.

The obvious remedy is to remove the bark, as is largely done with the hemlock, for tanning material, and might be done with the spruce, as a saving process, with great profit, although, in the latter case, the bark is worthless. Moreover, the peeling done in the forest hastens the drying, thereby lessening weight and cost of transportation, and preserving the whiteness of the wood, for which, in some uses, this quality is valued. Of course timber can be peeled to advantage only during midsummer, when vegetation is most active; and something is lost in quality of timber by cutting at this season.

The well-known fact that dead and decaying timber is sought by insects as their resting place has, in some cases, been used as a means for their destruction. For this purpose, decaying wood is placed in places where protection is desired, and the insects, laying their eggs in this by preference, may be removed and destroyed before their eggs hatch. This method cannot, of course, be applied to much extent with us, excepting in nurseries and orchards, but is worthy of notice. It follows that no such opportunities should be left to insects, unless thoroughly and seasonably attended to by removal, and that neglected rubbish may often become a source of great injury by harboring insects and favoring their increase.

GREEN-STRIPED MAPLE-WORM. (*Anisota rubicunda.*)

This is a lepidopterous insect, feeding on the leaves of the soft maple, and sometimes on the oaks. It occasionally becomes abundant in the Western States, and in 1867 stripped the soft maples around Peoria, Galesburg, Princeton, and Monmouth, Ill., but did not attract particular notice the next year.[1]

REPORT TO KANSAS STATE HORTICULTURAL SOCIETY.

Borers in fruit and forest trees.—A report on entomology, made to the State Horticultural Society of Kansas in 1875 (*Transac.*, p. 233) describes the habits and suggests remedies against certain borers in fruit and forest trees worthy of notice.

Flat-headed borer (*Chrysobothris*).—The larvæ of this beetle is very destructive to apple, pear, cherry, plum, quince, soft maple, willow, tulip, and mulberry trees, and

[1] Prof. Chas. V. Riley, in *Transac. Kansas State Board of Ag.* 1872, p. 297.

there was some evidence of its attacking the cottonwood and elm. In 1875 they appeared first on the 25th of May, were most numerous from the middle of June to the first of August, and a few were seen as late as August 26. They began laying eggs by the middle of June, under scales and in crevices of the bark, generally on the side most exposed to the direct rays of the sun, and in wounded places, formed by bruises, trimming, and sun-scalds. They infested only such trees as were debilitated by late transplanting, protracted droughts, extremes of heat or cold, sterility of soil, or neglect of cultivation. The larvæ could not survive a vigorous flow of sap nor continued shade. The eggs were deposited in the middle of warm, sunny days. As a remedy, the committee proposed the following:

Plant early on ground well prepared and plowed the fall previous; remove a large part of the last year's growth, and mulch for a space of two feet at least around the tree; wrap the trunks in hay, paper, or rags, and cultivate well. This tends to secure strong, vigorous growth, and is itself a strong safeguard. Search should be made for the larvæ, which leave but slight external traces, but the practiced eye soon learns the indications, and a sharp knife and probe will find them.[1] In September they begin to penetrate the wood, and get beyond reach till they emerge as perfect insects.

Round-headed borers, (*Saperda*).—These emerge from the tree early in June, are nocturnal in their habits, and they lay their eggs in the crowns of the trees or among the forks of the branches, or sometimes on the trunks when shaded. They attack healthy trees as well as those that are weakly, and their burrows are indicated by the dust that they throw out. The knife and probe will find the larvæ. The earth should be removed from the crown to a depth of four or five inches, and when the search is finished, it should be carefully drawn up again around the trunk.[2]

It has been recommended in fruit-trees, and would be equally practicable with others, to remove some of the soil from around the tree at the crown, and filling in and mounding up a little with lime and ashes. This would prevent the female beetle from laying her eggs so low down as to be beyond access, and might prevent her from laying any.

The "measuring-worm" did extensive damage in some parts of Ohio in 1870–'71. A writer, in noticing this injury, says:

It has been a very difficult thing to find a whole leaf on many of our forest trees during the last two summers. Every one was eaten and riddled by the worms. Not a leaf could be found in midsummer on a beech, oak, or white elm, or on many other trees, which had anything more than a skeleton left. * * * For some cause, there has been a great increase in those species called measuring-worms within a few years. The seasons, the mildness and dryness of the winters, especially the two preceding the present, have perhaps made conditions favorable for them to multiply. The effect of their ravages is to weaken the constitution of the trees, where they do not kill them outright. The trees become disabled and a prey to other insect enemies.[3]

Locust-borers attack the trees near the ground, and a remedy has been proposed, which consists in banking earth around the roots. It is claimed that in plantations of locust the chief injury is done around the margin of the plantation, which certainly appears to be the fact in Eastern Massachusetts. But in some Western States the whole plantation has fared alike, the ravages extending through every part. The insect that does this damage to the locust trees is the *Clytus robinæ* (Foster), of the beetle class.

In portions of the country where the locust trees have formerly been killed off, they are now raised successfully, and there appears ground for hope that this valuable timber may be again raised with profit in regions where it was feared that it would be impossible.[4]

---

[1] Dr. Fitch mentions three principal remedies: First, coating the bark with offensive substances; second, destroying the beetles by hand-picking; third, destroying the larvæ by extracting from the burrow. A wash of soap, lime, &c., early in June, would secure the tree from molestation. In dark, damp days the insects may be shaken off to some extent.—(*Transac. N. Y. Ag. Soc.* 1854, p. 729.)

[2] Dr. Fitch notices the great value of the woodpecker in destroying this and other borers. Of alkaline washes, he prefers common soft-soap. Mr. Downing recommended a mixture of soap, sulphur, and tobacco-water. The wounds made in searching for the larvæ soon heal. As the worm works downward, he proposed opening the upper end of the burrow and pouring in scalding-hot water.—(*Ib.*, p. 728.)

[3] Mr. John Hussey, of Loveland, O., in *Ohio Agricultural Report* 1872, p. 26.

[4] Mr. Arthur Bryant, in a paper read before the Illinois Horticultural Society, in 1872, urged renewed attention to the cultivation of the locust tree, notwithstanding

The white willow has been stripped of its leaves very often by the larvæ of the *Nematus ventralis* (Say). Its antidote is the dust of white hellebore sifted upon the leaves.

The mealy bug, or white aphis, sometimes infesting the leaves of the white pine, may be killed off by syringing the trees with soap-suds of whale-oil.

RAVAGES OF THE SCOLYTES.—REMEDY PROPOSED BY M. ROBERT.

In many parts of Europe the elms have suffered very greatly from a minute beetle, the *Scolytes destructor*, which, by mining its galleries through the bark, have by their multitude, and the abundance of their work destroyed great numbers of fine trees upon public grounds in cities. This insect prefers full grown trees to the younger class, and those somewhat enfeebled by age rather than trees in full health. A remedy has been practiced with success by Dr. Eugene Robert, in Paris and elsewhere, but this is not applicable in a large way in forest culture on account of its expense, although it may at times be applied to the trees in avenues and public parks. It consists in removing the outer portions of the bark, down to the living part, taking care not to wound the latter, and in carefully cleaning out decayed and unsound spots whenever found. The operation should not be performed in warm weather, and should include the trunk and larger branches, the smaller ones being simply scarified longitudinally. Trees thus treated present an unsightly appearance for some months, which is obviated by painting them with coal tar containing yellow ochre enough to give a natural brown tint. It is claimed that trees thus treated acquire new vigor of growth, and that as with the cork oak, they seem to thrive better without the outer bark than with it.[1]

INJURIES TO YOUNG PLANTATIONS BY GRASSHOPPERS.

Plantations of trees for ornamental purposes and for timber growth, in the States west of the Mississippi have suffered in recent years, in common with agricultural crops generally, from the ravages of grasshoppers, which, eating off the leaves and the bark of young twigs, have often destroyed young trees, and seriously affected the growth of larger ones. With the exception of the red cedar, no kinds have wholly escaped; but in cases where the supply of foliage was abundant, these insects have shown preference to some and have left others almost intact. The willows and cottonwoods have usually suffered most, while the conifers and the box elder have often remained uninjured. It is also observed that trees after four or five years' successful growth, acquire a power of endurance sufficient to carry them through with the loss of only the younger twigs, and that they will put forth new branches to

its wholesale destruction by borers a few years since. He had noticed that the insect, having finished its ravages, had disappeared, and that the young suckers from old trees had remained untouched. He was inclined to believe that, should it reappear in Illinois, it would be less injurious than before. This disappearance of noxious insects has been repeatedly observed in regard to those infesting other plants, and affords ground of encouragement in respect to the locust tree.—(*Transactions of Illinois Horticultural Society*, 1872, p. 244.)

[1] *Bulletin de la Soc. Botanique de France*, March 27, 1857. *Saturday Review*. (Lond.) January 8, 1859. P. 38. *Les Ravageurs des Forêts et des Arbres d'Alignement*, by H. de la Blanchère and Dr. E. Robert. Paris, 5th ed. 1876. The second part of this work, by M. Robert, describes his method very fully, as practiced under his direction as inspector of plantations in the city of Paris.

replace those altogether destroyed. Even in trees newly planted, shoots will often come up from the roots, where the main stem has been killed.[1]

As for remedies against grasshoppers, but few are found effectual. In several instances we have known of these insects being hindered from alighting upon a nursery of young trees by raising clouds of smoke on the windward side as they begin to appear on the wing. Where they are hatched upon the spot, and before the insects have acquired wings, they may be hindered from climbing the trees by fastening shields of tin, or locks of cotton around the trunks, or by smearing the trunk several inches with coal tar, or a wash of chloride of lime, copperas, and turpentine. But these precautions are of course applicable only in exceptional cases.

With respect to the influence of tree planting as a means for preventing the breeding of these insects, we have many facts to justify the theory that in a country properly interspersed with timber and groves of young trees the climatic conditions are unfavorable for their increase; and so far as concerns the damage that may be done by those hatched in such regions, that they would be no greater than those sometimes felt in dry seasons in the older sections of the country where grasshoppers have always been seen, but their ravages seldom severely felt. The clouds of these insects that come upon the wing, are bred in treeless and arid districts, and never in a country interspersed with groves and timber belts. There is some evidence to show that they prefer such treeless regions when they alight, and that they avoid woodlands where open fields are near.

MEANS FOR DESTRUCTION OF INSECTS INFESTING TREES.

Among the methods practiced with success for the destruction of insects upon fruit trees, and applicable to forest trees, may be mentioned the following:

Building fires in the evening, to attract millars and other insects, which fall into the flames and perish.

Jarring the trees by striking them with a heavy piece of scantling, padded at the end to prevent injury to the bark. Cloths should be spread under the trees to catch whatever falls. Some caterpillars that spin down on a silk fiber, may be swept down with a broom and destroyed.

Smearing the bark with tar, molasses, or printer's ink, or other viscid substance, or what is better, wrapping papers or cloths around the trunk, and applying the tar to these instead of the bark. The substance should be renewed as it becomes dry.[2]

Surrounding the trunk with leaden troughs filled with oil, coal tar, or other liquids. Applying discs of tin that, sloping downwards, pre-

[1] A part of the damages charged to grasshoppers in Kansas and Nebraska in 1874 was secondary, and was caused as follows: The defoliated trees, under a warm, wet, growing autumn that followed, put forth new foliage, and many trees blossomed late in the season. This was followed by severe cold in winter, which loosened the bark and killed the young wood before it had consolidated so as to endure the frost.

[2] A band of tar, 15 to 20 centimeters (6 to 8 inches) wide, renewed two or three times in the season, has been found an effectual safeguard against the egger-moth (*Lasiocampus*). The band is painted on at about five feet from the ground, the rough bark being first smoothed off. It should be done early in the spring, just as the insect begins to develop at the root of the tree. Several hundred thousand thalers have been expended in Germany for this object. An hectare of pine requires the labor of a man from three to eight days to smooth the bark, and from two and a half to seven to apply the first coat of tar. It is renewed in about half this time. The amount required is from 18 to 40 liters for the first, and from 6 to 20 for the second application.

vent insects from passing. Binding locks of cotton wool around the trunks, &c.

Washing the trunks and large branches with soft soap, or strong soap suds, or lye, or whitewashing with lime.

A wash, composed of one pound of flowers of sulphur and a peck of quicklime, mixed in a close vessel with a sufficient quantity of hot water to make it of the consistence of common whitewash, has been used with advantage as a remedy against insects and mildew in forest and fruit trees. It should be applied when freshly made, in April, using a whitewash brush.

Dusting the leaves of trees with lime, or with powdered hellebore, when the dew was on, has been mentioned as a remedy against leaf-eating insects.

Another mode of protecting trees from insects that crawl up the bark, consists in fastening a rope around the tree and nailing a strip of tin four inches wide around the rope so as to project above and below. The females of the insect whose larva is the cankerworm (*Anisopteryx vernata*) will lay her eggs under the rope, where they may be killed by applying kerosene.

Digging around the tree to kill or expose the larvæ to frost has been tried with success. Others scatter corn around the roots, and allow hogs to root among it, thus turning up the soil, and doubtless destroying many of the pupæ. Late plowing, by exposure to frosts and to birds, will assist in destroying insects on their nests.

Hand-picking, the seeking of cocoons and nests of insects, especially in winter. Sweeping or burning down the nests of insects and seeking and destroying them in their burrows have been practiced with success.

The vapor of benzine has been proposed as a remedy against insects infesting wood work. The injection of mineral salts and of creosote, &c., is a preventive against insect damages to timber. The sap-wood of white hickory, so liable to injury from boring insects, even after worked into spokes or made into carriages, is sometimes protected by these chemical processes.

The apple-leaf crumpler sometimes contains the eggs of parasitic insects which would hatch, and by multiplying diminish the injuries done by this insect. It is therefore recommended to gather the affected leaves, and instead of burning them throw them on the ground in a bare place. The parasitic insects would hatch and be saved, while such of the noxious kind as hatched would perish before reaching a feeding place.

But many of the methods above enumerated are applicable only in a small way to trees in nurseries or favorite shade trees, and in forest culture we must seek relief from other sources, or, as sometimes happens, stand helpless and witness the great injuries done without hope of relief.[1]

Immense damages are also committed in fields and gardens upon grains and fruits, and here, as in the forest, there is often evidence

[1] In speaking of insects, we must distinguish between friends and foes, and not regard our allies as enemies, however disagreeable they at times become. The ant is treated by the German forester as his friend, knowing as he does the services which these little insects render. Besides furnishing in its eggs a dainty food to many kinds of song-birds, it pursues the larvæ of leaf-eating insects with great avidity, mounting to the highest branches in pursuit of its prey, and destroying these destructive parasites of trees in great abundance.

A nest of ants introduced in the midst of a plantation of cabbages has been known to protect the plants from the worms that were destroying it.—(*Revue des Eaux et Forêts*, xiii, 303.)

that an increase is often caused by the killing off of birds This leads us to consider more fully this important subject, so closely identified with sylviculture and with our agricultural interests generally.

TREE-PLANTING CONSIDERED AS A BENEFIT TO AGRICULTURE, IN PROMOTING THE INCREASE OF INSECTIVOROUS BIRDS.

In the Land and Forest Congress, held in connection with the Vienna Exhibition in 1873, much prominence was given to the incidental benefits of forests, in preventing sudden floods and eroding torrents, and by their affording protection to birds, thereby lessening the damages resulting to agriculture from insects. Resolutions were passed strongly commending to the various governments of Europe the necessity of passing stringent laws and regulations tending to this end.[1]

But as birds find their nesting places for the most part in groves and thickets, which come within the province of the forester's care, the importance of having woodlands scattered here and there between fields devoted to agriculture acquires for this reason additional weight. Early in 1874 this subject came before the National Assembly of France as a proposition for a law in the interest of agriculture to lessen the ravages of insects upon the crops, and a report was presented strongly urging its importance. This report cites in detail the recommendations of various societies, and specifies the birds that might be protected and those that should not, the latter being birds of prey of the larger kind that subsist only upon little birds.[2]

With the view of impressing upon children the necessity of protecting birds, the following circular was issued officially by the department having charge of the national system of education:

Circular of the minister of Public Instruction and the Fine Arts concerning the protection of insectivorous birds.

PARIS, *March* 31, 1876.

To Monsieur the Prefect:

The injuries occasioned to agriculture by injurious insects have within a few years become so great as to occasion much inquietude.

The Minister of Agriculture, and the Minister of the Interior have done me the honor of calling my attention to this sad condition of affairs, of which one of the principal causes has been the disappearance, or at least the diminution in number, of insectivorous birds. These birds, which are the natural guardians of our harvests, and the

---

[1] These resolutions were as follows:

1. We recognize the fact that, in order to effectually check the continually-increasing devastation of forests which is being carried on, international agreements are needed, especially in relation to the preservation and proper cultivation (for the end in view) of those forests lying at the sources and along the courses of the great rivers, since it is known that through their irrational destruction the results are a great decrease of the volume of water, causing detriment to trade and commerce; the filling up the river's bed with sand, caving in of the banks, and inundations of agricultural lands along its course.

2. We further recognize it to be the mutual duty of all civilized lands to preserve and to cultivate all such forests as are of vital importance for the well-being—agricultural and otherwise—of the land, such as those on sandy coasts, on the sides and crowns as well as on the steep declivities of mountains, on the sea-coasts and other exposed places, and that international principles should be laid down, to which the owners of such protecting or "guardian forests" be subject, thus to preserve the land from damage.

3. We recognize, further, that we have not at present a sufficient knowledge of the evils (disturbances in nature) which are caused by the devastation of the forests, and therefore that the efforts of legislators should be directed to causing exact data to be gathered relating thereto.

[2] *Journal Officiel*, February 24, 1874; *Bulletin Administratif du Ministère de l'Instruction Publique*, etc., 1874, No. 330, p. 211.

most precious aids to the farmer, are nevertheless almost everywhere treated as enemies. The husbandman, overlooking the constant services which they render to him, sees only the damages which they may do; children pursue them to extermination, either by taking them with snares or by destroying their nests, and these allies, whom foreigners come to purchase, for the purpose of acclimating with them at home, are gradually disappearing from our fields.

Various circulars have already been addressed to the inspectors of academies, and many notices inserted in the *Bulletin Administratif* of our ministry, with the view of stopping this destruction. Nevertheless, I feel it my duty to respond to the request made by my colleagues, by again claiming the concurrence of teachers.

I therefore pray you to address instructions to all the instructors in your department, that they shall teach their pupils to distinguish the insects injurious to agriculture from those which are useful, and that they encourage the children to destroy the former and protect the latter.

Teachers should also make their children understand that the destruction of birds' nests is injuring their own interests, as well as the interests of their families, and that in doing so, they show themselves both improvident and ungrateful. They should be reminded at the same time that by doing so they expose themselves to severe penalties. The law of January 22, 1874, which perfects and amends the one passed May 3, 1844, upon the police of hunting, in fact gives to prefects the powers necessary to prevent the destruction of birds, and to favor their increase. Prefectoral decrees have been issued to this end, and persons violating these orders are liable to a fine varying from 16 to 100 francs.—(1874, *art. II, Law of May.*)

Teachers should also, as opportunities occur, remind the heads of families that they are doing themselves very serious injury by allowing the destruction of nests, and that they are themselves responsible for the damages which their children may commit in this manner.

I will add, that in some communes that I might mention teachers have acted upon the happy idea of organizing among their pupils societies for the protection of useful animals. Such associations have rendered much service, and it would give me pleasure to see their number increased.

I attach, sir, the most serious desire for the execution of this circular, of which I pray you will notify me of the receipt.

Receive, sir, the assurance of my very distinguished consideration.

The ministry of public instruction and the fine arts.

WADDINGTON.

Various articles have also been inserted in the official bulletins enforcing the importance of the subject, and tending to excite a spirit of gentleness and sympathy toward these useful allies of the field. Our space will not admit of detailed notice of this important subject as a matter of European legislation and official protection.

Upon this subject, the *Journal d'Agriculture et d'Horticulture de la Gironde* makes the following reflections:

The truth is that small birds are disappearing more and more, and that races are becoming extinct. At this moment you might offer for blackbirds 1,000 francs the dozen, and the most skillful fowler would not guarantee to furnish one in the department of Gironde. But what destroyers of insects were these very birds! It is enough to see with what industry they will peck among the mosses in the fields, to give an idea of the innumerable number of larvæ of cock-chafers, worms, caterpillars, and other gnawing insects that they consume.

The nightingales, linnets, tom-tits, green-finches, red-throats, swallows, and sparrows are destroyed by myriads every day by instruments of every kind, and especially by the kind called "*pantes.*" In the department of Bases-Pyrénées, across which the birds make their principal migrations, every field has this contrivance in operation, and it is not uncommon upon favorable days to see a hunter return with his game-bag filled with some dozens of little birds.

And at the same time we complain of the ravages of worms in ears of corn, and damages of all kinds to the buds of our vines, exudation of gum, damaged grapes, all caused by enemies which the vine-dresser may seek in vain, because they escape his eye, and can only be destroyed by agencies which his eye cannot reach; but an instinct, keener than his own, knows how to find them, and from morning till night pursues them into their most secret retreats with a perseverance that never tires. If the little birds were spared, they would soon perform their useful office to the extent to which nature has designed them.

It is truly alarming to see brought into our cities so many sacks full of poor little birds, which afford but a trifling amount of food for man, and which render such valuable services by destroying millions of insects, whose ravages may be estimated at

hundreds of millions of francs every year. It is sad, indeed, that mankind cannot see this, and take measures for preserving the harvests, which at best cost him dearly, and for which he bestows so much care. From 100 to 200 millions' worth of crops might doubtless be thus saved every year, which would prove a very important item in the way of provision supply.—(*Journal Officiel.*)

A society for the protection of animals, in view of public utility, has, for some years, given honorary or pecuniary rewards to such children as have distinguished themselves by putting these principles in practice, and to teachers who have done most to promote these ends. Several agricultural and horticultural societies have taken active measures in disseminating facts tending to impress upon the public a realization of its importance, and the subject has received the attention of governments.

The disappearance of this class of birds, and a corresponding increase of insects, is not wholly due to the destruction of the former. They simply desert the regions where they no longer find nesting-places to seek other regions where they can. Some of them, like the woodpeckers, subsist upon the larvæ of insects found in decaying wood, and are starved out. Others love the shelter of woodlands near as a hiding-place from birds of prey, and do not forage far beyond their borders.

A spirited writer, in a paper read before the French Society of Acclimatation,[1] after enumerating the great services rendered to farmers by these allies of the field, says:

We have pointed out a natural cause for the diminution of birds in the widely-extending area of cultivation, and the destruction of woods, but the agency of this calamity, which threatens our agricultural interests with the greatest damage from the absence of birds is unlicensed hunting and the massacre to which they are given up by hunters, with all kinds of murderous devices, and the pillage of their nests and destruction of their young by children and by animals of prey.

Prohibitions against poaching ought to include not only the destruction at all seasons, by unlawful means, of game, properly so called, such as partridges, quails, pheasants, hares, rabbits, and deer, but should also stay the butchers of birds of passage, or those that remain with us, by any forbidden contrivances, or by poisoning. Let us see how it is in the different countries of Europe, along the borders of the Mediterranean, on the usual route of migratory birds. In France alone, from the department of the Maritime Alps to the Pyrenees-Orientales, all the heights along the coast are covered with the nets and devices of the hunters—traps, fall-nets, bird-lime-twigs, and snares, all ready to hold and kill the poor travelers the moment they have finished their perilous flight across the sea. In some of the defiles of the Pyrenees-Orientales, the catching with nets gives to each hunter, in half a day, from 200 to 300 birds, and this catch continues through the months of April and May. These quantities must be multiplied by that of the number of hunters, which is not less than fifty in this department alone, so that on "*good days*" they kill 10,000 of these little birds.

In the Var, the Bouches-du-Rhone, the Maritime Alps, and Génois, great hunting places with bird-lime are established upon olive plantations, which they hire for this use of the owner at from 40 to 50 francs the season. They cover the trees with their treacherous perches, and take daily, during days of passage, from three to four hundred birds. M. Pellicot, of Toulon, cites the case of a single hiring by the son of a leather-merchant, who, as a simple amateur, took, in the season of 1858, 1,800 birds. In 1859 the number fell to 800, and in 1860 to 600. Alarmed at this immense decrease, the sportsman abandoned his bird-lime. He had hunted only on Sundays and holidays, and from this instance what must be the sum total of destruction by those who make this piracy a daily business, and live only upon this abominable industry! We may add that in our single department, along a coast twenty kilometers (12.4 miles) in extent, east of Toulon, there are more than a hundred hunters with bird-lime, and they are not wanting to the west.

In Languedoc they capture quails by tens of thousands, as they come to the shore weary with their flight in April and May in quest of the regions where they breed. At a moderate estimate there are at least 20,000 quails destroyed in these months in the department of Hesault alone.

In an instructive little work entitled "Don't kill your friends," M. H. Lasserre relates that he has seen the inhabitants at Nice ranged in two files along the banks of the Paillon with poles to beat down the poor swallows that, hungry and weary from the

[1] Dr. L. Turrel, in the *Bulletin de la Soc. d'Acclim.*, 2d ser. ii, 497.

passage, had come thither in quest of larvæ and flies. We may justly accuse the departments of the south with abusive hunting of the insectivorous birds; but what shall we say of the organized massacres of the eastern departments? Let us listen to the eloquent and pathetic statement of a writer who, with an infinite amount of feeling and spirit, has made himself the advocate of these unfortunate victims.

"I have seen in my childhood, in Lorraine," says Toussenel, "all the trees by the roadside, the borders of the woods, and the feeding and watering places of the forest, set with poles by scores, so thickly that it was scarcely possible for the birds that might pass that wicked region to alight without falling into an ambush. * * * The landed property of France is wholly imperiled by the shameful ravages of devouring insects, which eat up one crop after another, and will finish by making themselves masters of the soil unless the administration takes effectual measures to prevent it."

The subject of insect ravages, as well upon field-crops as upon fruits and trees, has received much attention in our own country since the earliest period of agricultural and horticultural societies, and in several of the States commissions specially appointed have made elaborate reports upon it. Our limits will only allow a general reference to these sources of information, and to the discussions and essays published by these and other societies, many of which relate to the protection needed to insectiverous birds, and to measures that tend most to the increase of the latter. There can be little doubt but that with stringent game-laws, well enforced, and adequate opportunities to birds for nesting in groves and hedges, this balance of animal life, as it affects our agricultural interests, may be easily and permanently maintained, and that immense losses now annually suffered from insects may be saved.

Immense damages are done to wharves and other wooden structures by the ship-worm. This belongs to the class of molluscs, or shell-fish, and the remedies are chiefly found in the chemical preparation of the timbers, such as injection of creosote oil, &c. The subject of timber-preservation, although intimately associated with that of forestry, does not form a part of the present report.

INJURIES TO WOODLANDS FROM ANIMALS.

We have already noticed (page 105) the injuries that may be done by domestic animals, and the necessity of their exclusion where the undergrowth is an object for protection. Of wild animals, the rodents commit by far the greatest damage, especially rabbits, mice, and gophers, the first two by gnawing the bark, and the latter by eating off the roots.

As a protection against rabbits, several thicknesses of tarred paper, or corn-stalks, wrapped around the tree and tied with twine, has proved effectual. Smearing with wagon-grease, tar, blood, and lime have been tried. There is no remedy completely effectual short of the destruction of the animals.[1]

The POCKET GOPHER (*Geomys bursarius*, Shaw) is one of the most troublesome pests of the tree-planter in the prairie regions of Iowa, Kansas, and Nebraska. It is particularly partial to the roots of young trees, and a single animal has been known to follow a line of newly-set Osage hedge, destroying the roots for many rods. It derives its common name from a fold of the skin on each side of the mouth which, in burrowing, it fills with earth, and then coming to the surface it empties this load

[1] M. Courcier has submitted a letter to the Central Society of Horticulture, in France, giving a cheap method of protecting plantations against rabbits. It consists in surrounding them with a cord dipped in fish-oil, and supported 6 or 8 inches above the ground by stakes, which are cleft at the top so as to receive and hold the cord. The odor of the oil is said to be offensive to these animals. The cord should be dipped from time to time in the oil as its odor is lost by exposure to the air. Should this be found efficacious, we have an easy method for protecting nurseries. It is said that rabbits will sometimes abandon a locality where this odor is introduced by tanneries and the like.

by a sudden muscular contraction of the parts. It is somewhat difficult to kill, as it seldom comes above the surface, but may be poisoned by strychnine placed in a carrot, an apple, or a potato, and laid in the soil at the points where the burrows come to the surface. It is said to find a deadly enemy in the little striped skunk.

The BEAVER may be classed among the animals injurious to forests, chiefly from the destruction caused by the flowing of intervale lands by building dams. Such "beaver meadows" were common throughout the Northern States when first settled, and the areas thus flowed often covered hundreds of acres. This animal has been nearly exterminated by the hunters, excepting in the remote forest-regions of the Northwest, and in some of the swamps of the South. The cypress timber of Virginia is sometimes much injured by the beaver, which gnaws down the trees to get the young tender buds for food, and considerable destruction is still done by this animal in the Western Territories.

When DEER are shedding their horns, they sometimes damage trees seriously by rubbing off the bark. For this they select young trees still elastic and yielding. They also injure by eating off the young twigs.

Some injury is done by birds eating off the terminal buds of young pines and firs.

DISEASES, AND OTHER INJURIES TO FOREST TREES.

Aside from damages done by insects and other forms of animal life, trees are liable to various accidents and injuries, of some of which we can determine the cause, which may be avoidable, while at other times we cannot trace back to the origin of the evil, however sadly we may feel its effects. Among the known causes may be mentioned external injuries, want of air and light, stoppage or drainage of waters, chemical ac ion, exhaustion of soil, climatic vicissitudes, and fungus growths. Some of these we will more particularly describe, with such facts concerning them as appear most important.

The most disastrous feature of the timber question in the Rocky Mountain region is, the difficulty with which the forests appear to start when once destroyed, and left to the natural agencies, which in the timber-growing regions of the Atlantic States would, in a few years, again cover the surface with a luxuriant growth of young forests. Occasionally we meet with this effort at renewal in the region under notice, but these instances are exceptional rather than common. Professor Hayden, in his report of 1871 (p. 224), in speaking of this subject, says:

In traveling through the mountain districts, I was surprised at the large number of burned streaks that I observed. In some places we would not travel more than a mile or two without seeing either to the right or left a blackened belt stretching up the mountain side. If these spots would again be covered by a new growth, the result would not be so disastrous, but, as has been truly stated in the quotation (referring to a citation from Mr. Reed's article in the Transactions of the California State Agricultural Society for 1868–'69), this is not the case, for when once the forest covering is destroyed, it is never restored, but remains forever bare. Whether this be wholly due to the climatic conditions or not I do not know, but there are some reasons to believe that, even where undisturbed by the hand of man, the forests are gradually disappearing under the influence of natural causes. The smooth and rounded hills in parts of Wyoming-Utah, Southeastern Idaho, Southern Montana, and other parts of the Rocky Mountain, region have occasionally, here and there, a few trees which have every appearance of being the remnants of former forests. These hills bear unmistakable evidence of having been worn down by the action of the atmosphere, water, ice, snow, &c. The *debris* which has been worn down has covered up the former ruggedness of their declivities. * * * But where the original rugged declivity has resisted this action, there, almost invariably, forests will be seen. I have therefore come to the conclusion that the forests of the Rocky Mountains, as a general thing, are decreasing from natural causes, and I base my conclusions on the following grounds:

First. The wearing down of the mountains and hills; the *débris*, as it descends, destroying the forests on their sides. At Pleasant Valley (where the stage-road from Corinne to Helena crosses the range), in the basaltic cañon, this action even now appears to be in process, many of the blocks of stone having recently been loosened and rolled downward, carrying with them the pines, which may yet be seen. Here every stage of the process can be observed.

Secondly. In many places, at the last-mentioned point, at the head of Black-Tail-Deer Creek, along the headwaters of Sweetwater, the largest trees appear to be dying without any apparent cause, no evidence of fire being visible.

Thirdly. With the exception of two or three points, where the forest is once destroyed, it never renews itself. At one point west of the range, on the road from Helena to Deer Lodge, I noticed a grove of young pines or firs which were growing upon what appeared to be a burned district. At one or two points in the interior of the mountains, back of Denver, I noticed the same thing; also on the Baton Mountains. But the reverse is not only the general but almost the universal rule throughout this immense extent of the country. Add to this the immense destruction by fire, and the wanton destruction by human hands, and the prospect of timber for this section in the future is not very flattering. Unless there shall be some remarkable change in climatic agencies this decay must go on, as man has no power to prevent it; he may cease the destruction occasioned by his own negligence and wantonness, but he cannot stop the process on the mountains.

EXTERNAL WOUNDS AND INJURIES TO TREES.

An injury to the bark and wood of a tree may be noticed long afterward, as surveyors often have occasion to observe, in following lines marked by scoring notches into the trunks of trees on the course that they have to run.[1]

The "burls," sometimes seen upon the ash, black walnut, and other trees, appear to have been started by some external injury creating confusion in the deposit of wood-layers, which increased indefinitely when once begun. It would be worthy of careful experiment to ascertain how far these abnormal growths which sometimes greatly enhance the value of timber might be artificially produced.[2]

Winding grain.—This may occur in degree sufficient to lessen its value for hewn timber, as it always does for boards and for staves and other articles made by splitting. It is apt to be attended with cracks or fissures, which render it worthless except for fire-wood. The cause is unknown. Some species are more liable than others, the yellow birch, when large, especially so.[3]

---

[1] An instance of this occurred a few years since in Saratoga County, New York, in which a line marked in this manner 104 years previously, was followed several miles with unerring precision. There was often found in this case some slight scar or indication, which, on the spruce or hemlock, might be a black gum spot, and by cutting in from eight to nine inches the ancient ax-marks were found under this spot perfectly preserved. In hard woods the external marks were sometimes entirely overgrown, but the marks within were still plainly visible when laid bare by deep incisions in the trunk.

In one instance a hemlock was found on this line but eight inches in diameter, which, when marked, was but two inches thick. The growth through the century had been so slight that the years could only be counted, in the rings of annual layers, by the help of a magnifying glass, but having been exposed for the last five years to the full effect of the sun, these years presented a growth five times greater than at any similar period before. Cases have been recorded in which bullets, and the marks of ancient cuttings by an ax, have been found with a deposit of wood-layers over them, showing two centuries or more of growth.

[2] In support of this theory a case may be mentioned of the great elm tree that stood until lately on the corner of State and North Pearl streets in Albany, N. Y., which had many of these excrescences caused by driving iron hooks into the tree. These had been grown over entirely, leaving "burls" to mark the place.

[3] The white cedar, much used for telegraph-poles on lines in the Western States and on the plains, often shows a winding grain, and the direction is almost uniformly *against* the movement of the hands of a watch, or from left to right. We have not met with a satisfactory theory to account for this preference. The fact that it is occasionally in the other direction, and often in neither, appears to indicate that it is rather due to external and accidental causes.

Fissures or longitudinal cracks extending deep into the trunk. Our spruce (*Abies nigra*) is sometimes made worthless from this cause. The general opinion is that these cracks are caused by unequal contraction by cold or from the twisting of the winds, or from intense solar heat. They have been produced artificially by bending and twisting young trees as they are served by violent winds, or when loaded with snow and ice.

Concentric cracks (cup-shake).—The layers of wood for a part or the whole of the circle may be loosened; sometimes in old trees to such degree that the core will fall out of a block cut across the grain. These loose seams are sometimes marked by lines of a dark-colored fungus. They injure the wood for construction, are apt to admit moisture, and become the beginning of decay. They are deemed the effect of accident rather than disease, and may show no sign of their presence till the tree is cut.

Where the bark is loosened by any cause, as frost, the movement of winds, a violent blow, &c., a layer of wood may form under the bark, but there will be a solution of continuity with the previous layer, and so a concentric crack to the extent of the injured parts will remain ever after. It has been observed that reserves left in a coppice are more liable to this accident, as well as trees that grow in the open air.

Where the bark is removed nature seeks to cover up the exposed wood, and finally will do so completely if the task is reasonable. The tree may finally show no external trace of the accident, but the dead (perhaps not decayed) wood thus covered has no connection with the new covering, and the spot is more or less defective when afterward worked.

Rotten sinuses.—A dead branch admits water, and this, following down the fibers, may cause a rotten burrow, perhaps, of limited sectional area, but extending a long distance down the trunk. It is one of the causes of hollow trunk, so very common in the basswood, sycamore, and some other kinds of timber when they get large and very old. In fact there are few deciduous trees exempt from the infirmity of age, and it is a safe rule to cut such timber as soon as this condition is known, and the sooner the better. There are various kinds of discoloration liable to occur in the interior of trees, which have received distinct names among foresters. It is sufficient here to remark that they are mostly signs of incipient decay, and that they more or less impair the value of the wood according to the degree that they have impaired the strength of the fiber.

BLEEDING CREVICES.

Sometimes in the ash, elm, walnut, oak, and other species, there will appear a crevice, often caused at first by some injury, from which the sap will continue to ooze until, perhaps, it may bleed the tree indefinitely. Along this slimy, discolored crevice insects find lodgment; rottenness appears, and extends, and finally the tree perishes.

It is recommended by M. des Cars to clean out the crevice with a sharp tool down to the bottom of the diseased part, and apply coal-tar; repeating the process if necessary. In this way a valued tree may often be restored to complete health. Du Hamel advised the removal of the affected parts down to the live wood, and covering the wound with cow-dung mixed with straw; then binding with rags fastened by osier ties.

SOUND AS A MEANS OF DETECTING DISEASES AND DEFECTS IN TIMBER.

Wood is an excellent conductor of sound, when in perfect condition. The scratch of a pin may be heard at the further end of a long pine rod, and a light blow with a hammer is conveyed through a beam of timber of the greatest length with much distinctness. But if parts are decayed, or tending to decay, the homogeneity is destroyed, and the sound-waves are deadened. Hence we have an easy test of perfect condition, or, at least, evidence that there is no considerable rottenness within a piece of timber that might otherwise appear sound.

THE DRY-ROT.

This is one of the most formidable maladies in timber, beginning in the interior and spreading toward the outside, changing the fiber into a dry dust, and of course destroying it for every purpose. It is most likely to appear in warm, close, and moist situations, where the wood becomes covered with a brownish-white mold, which sends its fibers into the tissues, and it is now generally regarded as caused by the development of a fungus, known to botanists as the *Merulius lachrymans*.[1] This vegetation first appears as delicate white filaments, interlacing with one another, attacking the wood fiber, and changing the ligneous mass into a loose, celular tissue, that readily falls into powder. The surface may remain sound when it is nothing but rottenness within. It does not appear in the growing tree, and appears to be favored and developed by a fermentation of the juices.

Among the remedies are, thorough seasoning after immersion for a time in water, and the filling of the pores with an antiseptic mineral solution, as the chloride of mercury, and the salts of copper, zinc, or iron, or with common salt, which, but for its deliquescent tendencies, would answer very well. A cargo of salt, in bulk, is deemed desirable in new vessels on account of its benefit to the timbers.

Carbolic acid and other pyroligneous products are much used to check this tendency to dry-rot. Perfect ventilation, where it can be had, is an excellent means to prevent rotting.[2]

INJURIES TO TREES FROM FROST, DROUGHT, AND OTHER CAUSES.

Intense frosts will sometimes split trees in the direction of their fibers, and sometimes even with a loud report. Such trees are generally those that have some excrescences formed by a cicatrix covering an old cleavage containing water. These, when they are deep, seldom heal, and the timber so affected loses much of its value for uses requiring

---

[1] This fungus is described by Dr. Greville as follows: "Whole plant generally occupinate, soft, tender, at first very light, cottony, and white. When the veins appear they are of a fine yellow, orange, or reddish brown, forming irregular folds, most frequently so arranged as to have the appearance of pores, but never anything like tubes, and distilling, when perfect, drops of water." This last property gives it the specific name. It is often found in cellars where it is damp and unventilated, and in hollow trees.

Another fungus, the *Polyporus hybridus*, constitutes the dry-rot of oak-built vessels. It is described by Berkeley as "white, mycelium thick, forming a dense membrane, or creeping branched strings, hymenium breaking up into areæ; pores long, slender. minute."

[2] A list of remedies for the dry-rot would be a catalogue of most of the processes that have been devised for increasing the durability of timber. Many of these are noticed in a volume by Tho. Allen Britton, entitled "*A Treatise on the Origin, Progress, Prevention and Cure of Dry-Rot in Timbers*," 1875, 12 mo., pp. 311.

See also the "*Traité de la Conservation des Bois*, * * * by Maxime Paulet, Paris, 1874, pp. 414. Also the appendix of "*A Treatise on the Resistance of Materials*," by Prof. De Volsen Wood, 8vo, N. Y., 1875, in which many antiseptic and preservative methods are described.

strength. Trees growing in a damp soil, with an eastern or northern exposure, are most liable to these accidents.

Heavy winter frosts doubtless cause much injury to trees, when they do not entirely destroy them. It often happens that the branches alone are injured, while the trunk remains sound; and again, the trunk will sometimes perish and the root survive, and in condition to produce new shoots. Trees exposed to the north are, for obvious reasons, more liable to injury from this cause.[1]

Du Hamel remarks that vigorous plants, having a rapid growth, are less liable to damage by frosts than those in a feeble condition, and that when a tree has been much injured by frosts, the withered leaves will remain on through the winter.[2]

It is observed in the Eucalyptus, that after a few years the tree acquires a considerable degree of hardiness, so as to be able to resist frost, and although the young tree may suffer, the trunk will put forth fresh branches with undiminished vigor.[3]

The winter of 1871–'72 was particularly injurious to evergreen trees in the Northern States, and various causes were assigned for this fatality. It could scarcely be ascribed to insects, because the damage happened in the season when they are generally dormant, and although the summer following may have shown them unusually abundant in some localities, this might more properly be regarded as among the effects, rather than as a cause. It is well known that many of the Coleoptera burrow under the bark and through the sap-wood of dead coniferous trees, and to such an extent, that it is sometimes necessary to remove the bark from saw-logs to prevent serious loss. The same remark applies to a supposed origin from fungi, as these seldom spare a dead tree of this class, and as seldom appear in the tissues of healthy living trees.[4]

A third, and highly probable theory, ascribes the damage to a climatic cause; but whether this be unusual drought, cold, or other agency is unknown.

THE "ROUND DISEASE" OF THE PINE.[5]

For a long time sylviculturists have been occupied in studying a disease of the maritime pine, known in Loiret as the *maladie du rond*, and

---

[1] *Physique des Arbres*, ii, 130.

[2] *Ib.*, ii, 346.

[3] Martin *Ann. des Ponts et Chaussée*, Oct., 1877.

[4] Upon the high mountains of Essex County, New York, Prof. Charles H. Peck, botanist at the State Cabinet of Natural History, noticed the feeble spruces badly infested by a rust-fungus, the *Peridermum decolorans*, which attacked the leaves, and so discolored them that the foliage showed a yellowish hue to a considerable distance. It was not found on trees of vigorous growth in the lower regions, and might have been an effect rather than a cause.

The cold of the winter of 1872–'73 was of great severity. Its effect upon trees and shrubs at the Agricultural College, Lansing, Mich., is thus recorded by Professor Beal:

Uninjured and hardy.—Austrian pine, American weeping-willow, mock-orange, common and Persian lilacs, white pine, Pinus pumilo, flowering almond, gingko, black spruce, Lombardy poplar, locust, chestnut, snowball, red cedar.

More or less injured.—Norway spruce, bald cyprus (some small limbs most exposed were dead); cut-leaved Persian lilac (killed); horse-chestnut (a few injured a little); arbor-vitæ, fringe tree, tulip tree, Spiræa chamædrifolia (some injured); hemlock, ailanthus (dead at the top); Irish juniper (partly dead);) Cydonia japonica, tamarix, Robina hispida, small trees (dead to snow); double apple (one killed); double flowering cherry (grew but little,—otherwise looks well); Aralia spinosa (mosly killed); smoke tree (much injured); red-bud (killed to ground, as has often been before); roses (mostly killed to ground).

[5] Condensed from an article by Baron de Morgues, published in *La Reveu des Eaux et Forêts*, 1875, p. 186.

unfortunately common in Sologne, where it has done much injury. It makes its appearance in the pineries by attacking two, three, four, or five pines in a place, and every year from around these centers, some more pines die, leaving openings more or less circular, and sometimes widening out irregularly until whole forests are gradually destroyed. From its thus working out in a circular manner it has acquired the name above given. Among the causes assigned, are, by some, insects of different families, chiefly of the Coleoptera, certain genera of which live under the bark of these pines. Others think that it is communicated by the roots. Others, that it is due to old coal-pits, or places where fires have been made; and still others (we think with more reason), that it is due to conditions in the soil. It is remarked that it occurs oftener in gravelly soil, and very seldom where pebbles are absent.

As for these theories, it may be remarked that insects generally do not attack the bark of a vigorous growing tree, but only when it has come to the age of decay. Those who attribute the malady to insects appear to take the effect for the cause, and, moreover, the rooting up and even burning of the wood has never stopped the progress of the disease; and as the trees are always attacked in patches, it seems to be due to something inherent in the soil. In the midst of these infested places sound trees are often found, which could not be if the infection was carried by the roots. It seems more probable that these favored trees have penetrated to a better soil. Even the roots of trees affected have been found growing to those that were not, and attempts at isolation by digging trenches have failed.[1] The disease will sometimes stop without anything being done. As for the theory of old charcoal beds, there is little to support it. The disease appears more frequently in soils of fine sand mixed with sandy gravel than in silicio-argillaceous soils. As already remarked, the investigations that have been made have hitherto failed to fix with certainty the cause or to furnish a emedy.

The first years of the maritime pine show much vigor of growth till eight, fourteen, or eighteen years, and sometimes till twenty-five or thirty, according to locality. Beyond this it will sometimes begin in some points to lose a part of its vigor, an incident of apparently small importance, but affording some hint in the solution of the problem. It shows us that at this time the main root has met with a soil not congenial for it and perishes, and the mortality finally extends to the whole tree.

Toward the end of the last century, millions of larch were sown in England and Scotland in places that appeared unfit for other cultivation. As in the case of the maritime pine in France, these plantations in the first years made a vigorous growth, and, like them, as they grew old they fell sick; so that at twenty-five or thirty years many of them died standing, and like the pines became covered with mosses, lichens, and mushrooms. The disease was compared by some to the potato-rot in its destructive effects and obscure cause. The remedy appears to be, to seek other profitable species for cultivation where one has been found to fail. The *Pinus sylvestris* might perhaps with advantage replace the maritime pine. It has proved itself adapted to a wide range of climate and a great variety of soil, is easily acclimated, and would doubtless thrive in conditions where the maritime pine refuses to prosper. Whenever a given species begins to show a lack of vitality, as shown by a covering of mosses and lichens, the sap-wood becomes liable to the

---

[1] It is stated by M. Bagneris that in the Landes this disease has been stopped by digging a trench 0.7 meters (about 28 inches) deep around the infected part.

attack of insects, and we should take heed of these signs of premature decay, and not hope to escape loss of time and expense by endeavors to compel new plants to grow where the conditions have proved unfavorable. The Scotch pine itself has in some soils been affected by the malady above noticed, and from the presence of the mycelium of a fungus—the *Trametes radiciperda* in the liber and in the wood and roots—a writer has inferred that this is the cause of the injury.[1] But fungi, as well as insects, seldom attack wood until decay has begun, for it is in putrefaction that they find the nutriment essential for their development. We never see a vigorous-growing tree thus affected, and whenever these signs of disease appear, it is safe to conclude that the tree is on the decline. They should therefore be regarded as a notice to the sylviculturist that some of the conditions essential to life are wanting. These views of the cause of the *maladie du roud* may perhaps be criticised, yet they are not mere hypotheses, but are founded upon facts.

[In many parts of the Northern States the Norway spruce (*Abies excelsa*) after starting with great vigor, and growing twenty years or more, has lost its thrifty growth, and showed signs of maturity and decay, not unlike that noticed in the *Pinus pinaster* and *P. sylvestris* above described. It is reasonable to suppose that this may be from a similar cause, although no direct evidence has been shown. The conclusion, however, is quite obvious that if one species will not succeed in a given locality another should be tried. While instances may occur in which an exotic species may thrive with exceptional vigor, it is always safe to consult the evidences of capability shown by native timber-trees, and proper to adopt for planting those that have proved themselves capable of good results.]

RUST IN YOUNG PINE SEEDLINGS.

There is another special malady of the *Pinus sylvestris*, *P. larico*, etc., unfortunately too common, the "rust of the pine" which frequently attacks the young plants of these kinds, and which develops a parasite, the *Aecidium pini* (Pers.), the history of which we will give:

The *A. pini* (Pers.) belongs to the fungi, of the tribe of the *uredines* (rusts), the alternate generation of which has been finely demonstrated by the researches of M. de Bary; but we have never yet been able to detect its intermediate states, nor the plants of which it is the parasite. We know it only in one of its forms, the *A. pini*, a parasite of the *P. sylvestris* and its allied species. The mycelium of this fungus is developed in the needles, bark, and wood—colorless at first, and growing red toward the points from which it is about to produce the exterior organs of reproduction. The growths appear on the surface of the needles of the plant when two or three years old, and on the bark in the form of little yellowish brown or golden yellow spots. Plantations three to ten years old are especially liable to the rust, which becomes always less formidable as the plant increases in age. It is rare on pines twenty to thirty years old, and instead of attacking the whole of the top, it generally concentrates itself on some of the branches. It does not necessarily kill the plants attacked, but still its persistence may work the complete loss, and it often proves a real calamity in nurseries of this species. We must not confound this disease with that which sometimes appears in pine seed-beds in the spring-time, in which the young plants become red, and often die. This is supposed to be due to a climatic cause, and will be more fully considered in another part of this report.

---

[1] *M. d'Arbois de Jubainville.*

DISEASE OF THE LARCH.

The larch has suffered in Scotland within the last thirty or forty years from a disease which is becoming very common, in fact universal, and there has been found no remedy, short of cutting out diseased trees and replanting, with no assurances then that it will not reappear in the new plantation. It is said to be from atmospheric causes, and it first makes its appearance in a fungus-like growth on the stem of the tree, generally near the axils of the branches, then develops itself into or produces a blister, and eventually a hole or wound, as if a branch had been roughly broken off.

This cause, together with a decline in prices from the importation of foreign timber and substitution of iron in ship-building, has of late years tended to a discontinuance of planting new forests of larch in Scotland. The decline in prices may be judged from a statement made concerning this timber on the estate of the Duke of Athol, which had been valued at £1,000 per acre when mature, but would not now realize more than £150 to £200.

Since the appearance of the larch disease in Scotland, poplar wood has been to a considerable extent employed for the uses to which the larch had been formerly applied. It has, therefore, become an object of cultivation, mixed with spruce or Scotch fir and larch. The species most suitable in that country is said to be the *Populus monilifera*, there called the black Italian poplar. It will grow in sixty years to 120 feet in height in sandy alluvial river-banks. Its wood is tough and light, and when 2½ to 3½ feet thick at the base, is there worth 1*s.* 4*d.* per cubic foot and upwards.

The *P. canescens* yields wood of better quality, being light and strong, while its rate of growth is equally rapid.

DESTRUCTION OF THE SCOTCH PINE BY A FUNGUS PARASITE IN THE ROOTS.[1]

In the communal forest of Marchiennes, in France, the pines when about 50 years old were observed to be dying at a point which, widening in a circular way from year to year, showed, in 1874, after seven years of progress, a dead area of about 150 yards across and about 500 trees destroyed. Its obviously contagious nature led to a careful examination, and the mycelium of a fungus was found upon the stumps, the parasite itself being concealed in the ground. It proved to be the *Trametes radiciperda*, as named by Robert Hartig, from observations made near Neustadt-Eberswalde, near Berlin. The mycelium is developed in the liber and wood of the roots of the *Pinus sylvestris*, and sends out numerous filaments visible only under the microscope, but on the bark it is quite visible to the naked eye. They present quite a variable appearance, being sometimes white, very thin, and branching, and spreading over the bark, and at other times shorter, yellowish, grouped in parallel bands, which come up over the bark and then descend to reappear again. Very rarely, under a lens, isolated filaments present an irridescent play of colors. A root thus affected, when broken and exposed some days to the air, will have the broken surface covered with tissues as white as snow. When once established under the bark of the roots the plant slowly dies, and the contagion reaching the root of an

[1] An extended notice of this malady is given in the *Revue des Eaux et Forêts,* xiv, p. 105.

adjacent tree slowly passes along the nearest root to the main roots, and so slowly spreads. The dead trees are not injured for commerce, the wood not losing any of its qualities by the death of its roots, if seasonably used.

The remedy appears to be—to wholly eradicate the infected roots and burn them. It might be prudent to surround a center thus affected by a ditch deep enough to cut off all the roots, taking care to keep it free, so that no contact could be had with neighboring trees. A mixture of other species with the pine appears to prevent the disease, which has only been observed where there are dense masses of the pine with no other species. The beech appears to be also liable to the attack of this parasite, and therefore would not be proper, although it grows well with the pine. The spruce and the fir have not been observed to be injured and might therefore be used, although their growth in a pinery is not the best.

INJURIOUS EFFECTS OF SMOKE, AND OF NOXIOUS GASES UPON TREES.

It is well known that the emanations from certain chemical works, and from lime-kilns, furnaces, and other establishments that send out noxious vapors, will more or less injure the vegetation near them. In cities, the deposit of smoke upon the leaves will more or less injure their growth. As a general rule, trees with thick, leathery, and glossy leaves are less injured by smoke than those having a downy or pubescent foliage. But evergreens, properly so called (coniferæ), will not as a rule thrive so well, as they do not shed their foliage completely at any time, and are not washed clean by the rains.

The following list has been given by an observer who has made this subject a study, as comprising trees and shrubs that are best adapted to smoky situations:[1] *Platanus occidentalis*, *Acer dasycarpum*, *Populus balsamifera*, *P. fastigata and P. alba*, *Quercus ilex*, *Tilia europea*, *Fraxinus*, *Robina*, *Cytisus*, *Laburnum*, *Syringa*, *Ulmus*, *Ligustrum*, *Vinca*, *Viburnum*, *Tinus*, *Philadelphus*, *Cratægus*, *Ampelopsis hederacea*, *Clematis*, *Aucuba japonica*, *Ailanthus glandulosa*, *Ficus carica*, *Cydonia japonica*, *Hedera helix*, *Jasminum officinale*, *Rhamnus alaternus*, *Ribes sanguinea*, *Sophora japonica*, *Ilex aquifolium*, *Sambucus*, and *Leycesteria formosa*. Among the palliative remedies proposed are the following:

(1) Give more free space around each individual tree.
(2) Prune early, regularly, and judiciously.
(3) Soak well during drought the entire garden; and
(4) Top-dress with fresh soil over the roots and shrubbery occasionally.

A short supply of water to the roots of trees, as well from the drainage of deep sewers—as from the closing of the surface by impervious pavements, concrete, and hard-trodden streets, appear to be active causes of the stunted growth and early decay of trees in the streets of great cities.

Trees in parks and thoroughfares sometimes suffer from this cause, their roots being prevented from receiving the benefit of rains. The remedy is obvious, and the injury may sometimes be prevented by anticipating the wants by providing ample space of pervious soil above the roots.

The *Platanus occidentalis* appears to be particularly well adapted to

---

[1] Robert Hutchinson, of Carlowrie, Kirkliston, in a prize essay on the "Effects Produced on Trees and Shrubs by Smoke from Public Works." *Transac. Highland and Ag. Soc.*, 1876, p. 191.

city growth by reason of the bark falling off from time to time, exposing fresh surfaces to the air.[1]

Experiments were made in the botanical garden at Berlin of the effect of gas upon the roots of trees—pipes being laid so as to leak 100 cubic feet of gas a day under the roots of a maple, and 50 feet each under two lindens. At the end of two months, all the roots of the maple were dead, and decay had begun. One of the lindens still held its leaves, but showed signs of hopeless disease. The other flowered the next spring, but the trunk became covered with the same parasitic growth as the other, and showed evident signs of failure. The signs of poisoning were sooner shown in the soil that had remained compact than in that which had been disturbed.[2]

CAUSE OF THE "SCHÜTT" DISEASE OF YOUNG PINE PLANTS.[3]

In most parts of Germany where young pines are cultivated to a considerable extent, experience has shown that for a period of over 30 years, the leaves of the young pines in the spring will suddenly become of a yellowish brown, or brownish red, and in a little time drop off. This appearance is called in Germany the "Schüttkrankheit," and it is much dreaded by foresters, on account of its frequency, and its destructive effects. At almost every convention of foresters this subject has been brought up for discussion, and many opinions have been expressed as to the cause.

It is a disease of recent times, and has only prevailed extensively since the business of pasturing swine in woods, and natural seeding had been discontinued, and since these plants have been raised upon cleared ground in seed-beds. The observations upon this disease may be summed up as follows:

It has been observed on the common pine (*P. sylvestris*) and only appears when the plants are from two to five years old. The younger the plants the greater is the injury. It appears only in the spring, and, according to location and weather, from March till May. The dying of the leaves begins on the lower branches, and extends upward. The disease appears so suddenly that the finest tracts of pine plantations will, in two or three days, present the appearance of having been burnt over. The Bavarian ministerial bureau of forestry recommended the planting of yearling pines having long roots, in deep holes, as a precautionary measure. The malady has appeared on all kinds of soil, but has proved most destructive upon those that are poor, wet, sandy. In the mountainous regions the culture of pine is less affected from this cause, and it is observed that southerly and westerly aspects are more liable to injury than those of other points. In the more northern pineries it has not yet appeared. In cold countries, as in Russia, it has been observed in only very slight degree, and a correspondent of the *Forst und Jagd Zeitung* (1860), in writing from Moscow, says that not one place had been seen there that had been thus injured.

This disease does not appear every year, but occurs more frequently, and with most severity after wet, cold winters with little snow, with occasionally heavy frosts. In March and April, when dry, with warm

[1] Some noble specimens of this tree, planted about 1755, adorn the grounds of the Pennsylvania Hospital, between Spruce and Pine streets and Eighth and Ninth streets, Philadelphia. They are 12 feet and more in circumference, and still in fine growing condition.

[2] *Revue des Eaux et Forêts*, xi, p. 161.

[3] From Dr. Ebermayer's *Physikalischen "Einwirkungen des Waldes auf Luft und Boden."* P. 251–261.

days and cold nights, the young pines will suffer the most, and they only recover if the soil is not too poor, and the spring and summer are not too dry. Otherwise, large numbers will die, and those that survive will be sickly for years, especially if affected in successive years. It has been observed upon newly-planted tracts, that this disease shows itself only in patches, and that plants sheltered from the midday sun are but slightly, if at all, affected. Pine seed-beds which during the winter and until May were kept covered with fir, spruce, or birch brush were never affected, while unprotected seed-beds in the immediate neighborhood suffered. If (as is done in the Ellwang forest in Würtenberg) fir seeds are sown among the already protected plantations of growing fir plants, they will not be affected. Like results are obtained by an intermixture of pine and spruce, or *vice versa.*

Opinions as to the cause.—In regard to the cause of this disease various opinions have been expressed. The origin of the evil has been sought for, as well within the plant itself, as in outward circumstances.

Many observers believe that the disease starts from the root, and that it is then brought on by root-rust (*wurzel rost*), root-gangrene (*wurzelbrand*), and defective roots, and it has been denominated a gummy organic disease of debility which takes its origin in the root, and by degrees extends to the leaves. Others ascribe the falling of the leaves to an internal disease—to interruption in the circulation of the sap, the incomplete formation of wood in wet seasons, before the setting in of winter—to insects, or to a fungous growth.[1] (*Hysterium pinastri.*)

The condition of the earth has also been considered as a cause. The disease is favored by a wet sour soil, and especially by a want of strength in the soil. According to some observers, it originates in consequence of clearing, while others ascribe it to a want of light. In the opinion of many, the cause of the disease may be found in the condition of the soil. The majority of foresters, however, adopt the view that its origin is to be ascribed to meteorological conditions, and that it is brought on by very damp unfavorable weather at unusually high temperatures, or by great and sudden changes of temperature in the spring, after cold winters with little snow. The clear nights and late frosts of spring are usually believed to have a bad effect, although it is known that the leaves of the common fir can endure a very low temperature, and that of all the coniferæ the pine is found farthest north (64° north latitude). Dr. Nördlinger, of Hohenheim, in his *Kritische Blätter* (1863), seeks the origin of this malady in the repeated chilling of the plants, in bare and unprotected grounds toward the end of January, and in February and March.

Cause of the "schütt" disease explained by the results of forest meteorological observations.—Observations on the temperature of the earth and ground, and a comparison of these records, have led to a new theory as to the cause of this disease. In order, however, to explain the contradictory experiences above mentioned, it is necessary to note a few laws of vegetable physiology that have reference to this subject.

The leaves of plants impart by evaporation during the growing season a certain amount of watery vapor to the air. The amount of this evaporation differs, not only in the different kinds of plants, but it also depends in the same plants upon external conditions—the temperature of the air, the intensity of light, and on the amount of moisture in the air and in the soil. The greater the warmth of the air, the more intense the solar light, the drier the air, and the moister the soil, by so much more will plants give off moisture from their leaves, the transpiration

[1] So far as known to us, this fungus on pine plants that have died from this cause, has not been shown by the microscope.—*Ebermayer.*

under these conditions being more active. In this respect, light affects plants to such a degree that even passing clouds will lessen the evaporation. The result of all the observations thus far has been to show that under like circumstances the transpiration is greatest in the direct light of the sun—that is, less in common day-light, still less in the shade, and least in the night. Risler found by his investigations[1] that in the lucerne the amount of water evaporated in the sun is four times greater than it is in the shade. The difference of evaporation in the two conditions is with this plant considerably greater than with corn. In some plants, as in the willow, it is, however, very slight. This is, no doubt, the reason why some plants will thrive better in the shade than others. Transpiration is also diminished by a fall of temperature, and an increase in the humidity of the atmosphere. With the decrease of warmth, and the lessened influence of light, the transpiration of plants becomes less in autumn, and finally stops entirely, causing the falling of the leaves. The evaporation from the leaves is very slight in a damp or foggy atmosphere, and when the leaves are wet by dew or rain. In the damp air of our hot-houses, and under glass vases, often placed over weakly plants, the amount of evaporation is very slight. It is correspondingly lessened in the shade of trees, in the cool and damp air of dense forests, and under artificial coverings.

In order that the leaves of plants may remain fresh and plump, as much water must be taken up by the small fibers of the roots as is lost by transpiration. A constant circulation of water is going on from the roots through the trunk to the branches, and through these and the stems into the leaves. The plant remains in a normal condition whenever the supply of water by the roots and loss by evaporation correspond. Under some circumstances it will occur that the supply of water received through the root is greater than the loss through the leaves, or that the loss is greater than the supply. Instances of the former case are presented in the plant which during the night evaporates less water than it receives from the ground through the roots. The surplus is deposited on the leaves in small drops, which, upon examination, may be found early in the morning, even in hot-houses, which precludes the idea that they are gatherings of dew. Another instance is shown in our deciduous trees in autumn after the fall of the leaves, when, from a relatively warm soil, the roots maintain their activity, and continue to receive moisture from the soil, which will remain in the body of the tree, as the organs of evaporation are gone. This explains the reason why there is a greater amount of water in the body of a tree in autumn than there is in summer. It is oftener the case, however, that the amount of water lost is greater than that received, which occasions in herbage and young plants a withering of the leaves. Larger trees are not materially affected by this interruption, as the body of the tree acts as a reservoir of water, from which the leaves are supplied for some time. The withering and drying up of plants is not always the result of an insufficient amount of moisture in the soil; but it may occur when, in consequence of a lack of activity in the roots, the absorption of water from soil is not proportioned to the loss by transpiration.[2]

The activity of the roots is influenced chiefly by the temperature of the earth. In a warm soil this, and consequently the absorption of water,

---

[1] *Der Naturforscher*, February, 1872, p. 45.

[2] Plants will dry up when the number of small fibers of the roots is too small in proportion to the amount of leaves—a frequent occurrence in the transplanting of large plants when their roots are injured in taking up.

is greater than in a cold one. If, therefore, the temperature of the soil is too low, the absorption of water by the roots is not sufficient to supply the loss of evaporation by the leaves, and the plants may wither and die, *although the soil contains sufficient moisture.*

Experiments made by Professor Sachs have shown that the roots of tobacco and cabbage in a moist soil, the temperature of which had fallen below 5° centigrade (41° F.), did not absorb water sufficiently to supply the loss by evaporation, in consequence of which the plant wilted.[1]

By our observations, extending through a series of years, we find that in the months of March and April (according to location, condition of soil, and weather) the temperature of the earth, even at a depth of four feet, often barely reaches 4° R. (41° F.), while the temperature of the air is frequently from 15° to 18° R. (66° to 72° F.) higher. On account of the cold in the earth prevailing at this season, the activity of the roots of plants is weak, and the absorption of water proportionally small. In plants which at this season have organs of transpiration, which is the case with evergreens, the same results may occur as with the cabbage and tobacco in a degree proportionate to their exposure to direct solar light. All of these results point to the fact that the "*Kiefer-Shütt*" is not a disease caused by frost, but a drying up and withering of the pine leaves occasioned by the high temperature of the clear days in the early months of spring, and by too great insolation of the unshaded plants in the clearings.

This wilting differs from that which occurs during the summer in this, that the insufficiency of water in the plant, occasioned by transpiration, is not caused by a lack of moisture in the soil, but by an insufficient activity in the roots, in consequence of which the leaves must die. The greater the difference between the temperature of the air in the direct light of the sun, as compared with that of the earth, by so much more frequently and destructively will this disease appear. Every circumstance tending to increase the temperature of the earth, or to reduce that of the air, or to lessen the intensity of the sun's light, and consequently to retard the evaporation of plants, would therefore operate against the appearance of this disease.

The temperature of the earth during the early spring months depends on the severity or mildness of the preceding winter. In the spring following a winter with an abundance of snow, the soil is warmer than after one in which there has been but little snow. Wet soils under circumstances otherwise alike, will be colder than those that are dry. Sandy soils cool off by radiation more quickly than clay soils, during the night. The soil in seed-beds which have been covered with straw during the winter, is warmer than that which has been left uncovered. Warm rains contribute largely to the raising of the temperature of the earth, while by frosts in clear nights the temperature of the earth is considerably lowered to a depth of six inches. It is from this reason chiefly that late frosts have any relation to this disease.

The temperature of the air, and the intensity of light, of course reach a greater degree in clear days in the spring time than under a clouded sky, and as evaporation in plants is hastened by the direct light of the sun, the reason becomes apparent why this malady appears oftener in the spring, in clear days, and in places most exposed to these changes, as, for example, those with an eastern or southern exposure—on bare

[1]A discussion of the question of the movement of water in plants is given in detail at pp. 598–614 (English edition) of Sachs's *Text Book of Botany, Morphological and Physiological* (1875). See also *Botanical Gazette*, 1860, p. 124.

plains and on unprotected grounds, as is so often seen on plant-beds on the south side of forests which were not covered.

The pine plants are more or less spared from this disease by rainy cloudy weather in the spring, and by being located on northerly slopes, or where protected by a growth of timber, as on the north and west sides of forests, or by artificial protection, or by growing between tall spruce plants, or by weeds.[1]

The evaporation of plants is increased in the spring, especially in the month of March, by the extraordinarily dry air which the polar current often brings to us during this month. The disease, therefore, appears oftener in clear, warm spring days, with warm dry air. The reason why pine plants, from five to six years old, are never or but seldom attacked by this disease is thus explained: The trunks of the trees form reservoirs of water for the leaves, which supply the loss sustained under the circumstances above described. It is determined from observation that closely-growing plants are more liable to the disease than those growing sparsely. Young plants transplanted will bear the disease better than those raised from seeding. All of these experiences are explained by the more or less complete development of the roots. The greater the number of small fibers in the root (which are the organs for absorption of water), the easier the plant is enabled, even with less activity of the root, in a cold soil, to supply the loss of water by evaporation, and to withstand a drought. In localities that are too open, the development of the root is imperfect, and care must be taken in the transplanting to use such plants only as have well-developed roots.

For this same reason with respect to the roots, this disease does not so often affect plants on strong but loose soils as on those that are poor or very compact, because in loose soils, under circumstances otherwise similar, the development of the roots is more perfect, and their spread greater, than in soils that are more compact. Besides the better development of the roots, the loosened soil has the advantage of more easily admitting warmth and moisture in the spring.

By aid of the foregoing explanations, and upon the conclusions fixed by meteorological observations, we may easily explain the causes of the appearance of this disease, under different circumstances. To fix beyond a doubt the correctness of the theories offered in regard to the causes, experimental proofs are only needed, a task which will be undertaken at an early day.

The means which the forester can apply, to prevent the appearance of this malady, are therefore apparent. All forestal manipulations in transplanting must tend either to increase the temperature of the earth, in the early months of spring, or to reduce the transpiration; that is, to weaken the intensity of the light. The former is, however, difficult to attain in large plantations. In seed-beds the radiation of heat can be lessened in some degree by placing a thick covering of moss or leaves between the rows of plants during the winter. In large clearings, if the soil is wet, drainage would improve it; in other soils, loosening as deep as practicable, and, according to circumstances, an admixture of humus, will tend greatly to the more ready penetration of warmth into the earth. A lessening of the transpiration can be effected by weakening the light by shading. Seed-beds may be protected by evergreen brush, which must not, however, be removed in clear, warm days. Seed-beds should be so located as to be protected on the south side by a forest. In pine reservations on a large scale, the most effectual means of protection will be to

[1] If grass or weeds be allowed to grow too high, so as to cover the plants from above, they will destroy them by depriving them of the necessary amount of light.

return again from total clearing to the practice of partial clearing, in order that the young plants may be protected by the standing trees, and thus receive the necessary protection from the direct rays of the sun.

In the cultivation of large cleared areas, the necessary shading can be secured by previously planting such trees as the soil is particularly well adapted to produce, such as birch, &c., or of spruce plants in sufficient number. In cases, however, where, from local circumstances, this latter method is not practicable, yearling plants with well-developed roots should be set out; but the two former methods are best calculated to lead to good results. In southerly aspects, more attention should be paid to this necessary protection than in places with a northerly exposure. As a general rule, it may be remarked that everything tending to obstruct the full development of the roots, as, for example, thick seeding, or heavy compact soils, is injurious to the fibers of the root, and must be carefully avoided. One or the other of the above means, have already found application in the prevention of the disease in question, and while practical experience has been pointing toward them, every thinking forester can, with the aid of the above suggestions, decide for himself which is the most practicable method of pine culture.

DYING OUT OF THE BEECH.

For several years past, in the forest of Aulnay, France, the beech trees have been perishing in plantations fifty to sixty years old, so rapidly and in such quantities that they could not be worked up in time to be of value. After having dried up standing, they are overthrown by the winds, and rot upon the ground. Many of the trees that have hitherto flourished, show unmistakable signs of death, and serious apprehensions are felt in regard to forests where this is the prevailing timber. Careful investigations tend to show that in plantations made too close, and left in this condition too long, the soil becomes too much exhausted, and that having taken up all the elements that can be assimilated, they perish for want of more; or, becoming enfeebled in a dry season, fall a prey to insects, which trees in vigorous health would easily resist. A series of chemical analyses made in a study of this case tends to prove the chemical conditions that have caused the destruction of the beech trees as above mentioned.[1]

FUNGUS ON COTTONWOOD.

The "Poplar brand," or *Melampsora populina*, has done much injury to the cottonwoods of the West, especially in Iowa. It appears as an orange yellow dust on the under side of the leaves, which by impairing the functions injures the growth of the trees. No effectual remedy has been found.

STAG-HORN TOPS.

With a damp subsoil, or want of nourishment, trees will sometimes die at the top, presenting in their dry branches an appearance that gives them the name "stag-horn tops." Drainage will prevent this in some cases, and fertilizing in others. In some species these trees may be made pollards with advantage, but never with great benefit. If the soil has done all it is capable of, we can expect nothing more, as we have required too much.

If want of drainage was the cause, the dead tops should be carefully removed; when, with dryness, the tree may acquire a more healthy growth.

---

[1] *Revue des Eaux et Forêts*, 1874, pp. 357–362.

BARK-BOUND TREES.

It is well known among nurserymen, that trees will sometimes languish because the bark is so hard that it hinders expansion. The remedy is a light incision down the side of the tree with the point of a knife. It should be done in the spring, when the sap is starting; and its effect is quite apparent, within a year or two, by a notable expansion of the trunk, as shown by the strip of new bark along the line of the incision.

BARBERRY RUST.

It has long been a popular belief in England, that the barberry bush (*Berberis vulgaris*) has some agency in the propagation of rust in wheat and other grain, and the researches of botanists have somewhat tended to confirm this belief. The spores from grain rust (*Puccinia graminis*) are said to find their way to the leaves of the barberry, germinate and form cluster-cups on the under surface of the leaves, and the spores from these in turn germinate on the grain by alternate generation. The fact that rust sometimes appears in fields where there are no barberry bushes in the vicinity, appears to indicate that there may be other plants capable of bearing the intermediate form of growth. The clearing off of barberry bushes has been claimed to be followed by good results, and if it should be proved beyond doubt that there is a direct relation between this and grain rust, the use of barberry as a hedge plant should be wholly discontinued.[1]

THE DYING OUT OF FORESTS.

Mr. Dan. Millikin, of Hamilton, Ohio, in an essay on the best practical means of preserving and restoring the forests of Ohio,[2] makes the following statement concerning the death of the forests, with his opinion as to the cause:

> In some places, and to the great regret of proprietors, the remnant of forest is dying so rapidly that lumber is sold to avoid its rotting. I doubt if ten thrifty white-oak trees of a diameter of 2½ feet can be found in Butler County; all have dead tops and are on the sure road to decay and death. Other species are similarly affected in localities, and the Board of Agriculture does well to ask for the best method of preserving the forests of Ohio. It is proper for us to inquire into the causes of this blight, which is sweeping away the finest trees in the region where timber-growing just begins to be prized. The soil of the ancient forest was spongy in its structure, and was less liable to extremes o heat and cold and drought than treeless soil. For ages the trees had been drawing nutriment from all strata, so that by the fall of their leaves, and the fall and decay of successive generations of the trees themselves, great amounts of plant-food had become stored in the very uppermost layers of the soil. Hence later generations of trees had come to live mainly in this upper soil. Even the oaks and the nut-bearing trees had extensive root-systems near the surface, and many genera now flourish which habitually live near the air. When the forest is brought under subjection by the American farmer, the saplings are cut out "to give the big timber a chance." All small bushes are grubbed up or are browsed away by domestic animals. Brush, leaves, and rotten logs are burned by accident or design. Cattle are freely admitted to the forest because at some seasons the pasturage is good, and because at other times they cannot go upon tillable land.

The trees thus injured, the temperature becomes less uniform, winds and the sunlight reach the soil and the rains are not retained as formerly, and the surface becomes grassed over. The remedy proposed is the preservation of the young timber, exclusion of cattle, and the planting of young forests where the old forest grew. He was convinced that this would be profitable nearly everywhere in Ohio.

---

[1] See papers upon this subject in *Report of Mass. Hor. Soc.*, 1877, part 1; and *Report of Maine Board of Agriculture*, 1869, p. 178.
[2] *Ohio Agricultural Report*, 1871, p. 335.

The Rev. John Croumbie Brown, in his report as Colonial Botanist at the Cape of Good Hope for 1865, p. 77, notices the destruction of chestnut and walnut trees in different parts of that colony, and deems it quite probable (although not directly proved), that the decay may have been caused by water in excess at certain seasons of the year. He does not regard this as inconsistent with the fact that great drought occurs at other seasons.

ALTERNATIONS IN TIMBER-GROWTH.

The track of a tornado through a forest, may sometimes be traced long after the space has grown up with a new crop, by the difference of timber.

In 1845, a wide strip of forest was thus prostrated in Northern New York, the track extending from the settled regions of Jefferson County to Lake Champlain. The timber was beech, maple, birch, ash, hemlock, spruce, &c., and in its place we have now poplar, cherry, birch, and a little beech and ironwood.

In New England, the pine is often succeeded by the white birch, and in New Jersey by the oak. The succession of oak by pine, and the reverse, in the Southern States, was noticed long ago.[1] The white-oak timber cut off at Valley Forge, for fuel in the American camp, in 1777–'78, was followed by black oak, hickory, and chestnut. Poplars and other soft woods are very often found coming up in pine districts that have been ravaged by fire. We have noticed in Nebraska, ash, elm, and box-elder following cottonwood. In the natural starting of timber in the prairie region of Illinois, when the stopping of fires allow, we often see a hazel coppice; after a time the cratægus, and finally the oaks, black walnuts, and other timber. These growths are often quite aggressive on the prairies. In Florida the black-jack oak usually takes the place of long-leaf pine.

This alteration of timber was noticed by Sir Alexander Mackenzie, in an overland journey to the Arctic Ocean in 1789. When in the vicinity of Slave Lake, he remarked:

> The banks are covered with large quantities of burned wood, lying on the ground, and young poplar trees that have sprung up since the fire that destroyed the larger wood. It is a very curious and extraordinary circumstance, that land covered with spruce pine, and white birch, when laid waste by fire, should subsequently produce nothing but poplars, where none of that species of tree were previously to be found.[2]

The elevated region around the headwaters of the Delaware, Allegheny, and Genesee Rivers, when first brought to notice for settlement, was covered with a heavy growth of hemlock (*Abies canadensis*), or with forests of beech or sugar-maple; but there is some reason to believe that at an earlier period this region was covered with oak. In a letter from John Adlum, of Havre de Grace, Md., to Judge Peters, of Philadelphia, September 16, 1807, he says:

> As to your query respecting a rotation or succession of forest trees, I am as well satisfied of it, in my own mind, as if I had lived to see the whole change for centuries back. I took the idea in the summer of 1788, when surveying the lands south of the great bend of Susquehanna, between that river and the Delaware, in what is called the beech and sugar-maple country. In the course of my surveying, I traversed some places, consisting of a few acres each, growing red and white oak trees of an enormous size, none being less than sixteen feet in circumference five feet above the ground, and generally from forty to fifty feet to the first branches. Some few red oaks were 22 feet

[1] *Memoirs of Philadelphia Agricultural Soc.* 1814, i, 41.

[2] *Voyage from Montreal* . . . . to the Frozen and *Pacific Oceans* in 1789 and 1793, vol. 1, p. 22.

in circumference, and the white oaks 20 feet around. I was struck with astonishment to meet a few trees of the oak kind, considering that I had not seen any for some weeks. After discovering the first few, I kept a lookout for more such places, and, as well as I can remember, I found two more of the same kind, containing trees of the same enormous size, but no small oaks nearer than the large waters emptying into the Susquehanna and Delaware. The places mentioned were near the heads of those rivers, and where the streams were small. I invariably found small bodies of very large hemlock trees (the prevailing timber) near these places; the remainder of the trees consisted of beech, sugar-maple, with a few white walnut, white ash, birch, &c., but no oak.

In those parts of the country where the prevailing timber consisted of sugar-maple, beech, and birch, I observed large trees growing, as it were, on stilts, their roots being three feet above the ground, which trees undoubtedly grew on old logs that had either fallen with age or had been blown down by hurricanes, and had rotted down from the roots of the trees.

The clumps of oak and hemlock are generally in the midst of or surrounded by large bodies of beech and sugar-maple lands, mixed with some ash, and a few wild cherry and hemlock trees. In some parts of the country, the prevailing timber is still hemlock on the sides of hills and along streams.

From the circumstances of the great size of all the oak trees growing in the spots noted above, it appears to me that most of the high country, including the headwaters of the Delaware, Allegheny, and Genesee Rivers, was originally an oak country. The hemlock appears to have succeeded the oak, for there is still a considerable quantity of that timber over the face of the country, but from the number of logs of it lying on the ground, and its still visible decline, I think the beech, sugar-maple, &c., succeeded the hemlock, as they are the prevailing timber at present. The timber that appears to me will take the place of all others in the country before mentioned is the white ash and wild cherry.

An instance is mentioned in Ohio in which a storm-track had grown up with black walnut,[1] and in fact examples might be multiplied indefinitely without arriving at any definite rule of succession by which the change could be previously known. These alternations of forest growth, sometimes coming on gradually and at others at once, when the ground is clear, have been regarded as arguments in favor of a rotation in farm crops, the soil appearing to become exhausted of the elements suited to the growth of one species, while becoming fitted for another. This theory may still have its advocates, but it may be easier to account for it by supposing that the seed is derived from neighboring trees that here find a lodgment under circumstances peculiarly favorable for growth. Some of them, like the poplars, and those with winged seeds, may be borne by the winds to great distances, and where a heavy forest growth is wholly removed, it often occurs that young plants of other species already scattered here and there find their opportunity and improve it before the seed of the former timber growth, if sown, could germinate. The aggressive nature of the soft woods in young forests is one of the plagues of forestry, and care is often needed to prevent them from shading out the more valuable kinds.

In the region around Green Bay, Wisconsin, overrun by fires in 1871, dense growths of poplars and birches have sprung up and are growing rapidly.

At Clarksville, Ga., oak and hickory lands, when cleared, invariably grow up with pine. This is true of that region of country generally.

At Aiken, S. C., the long-leaf pine is succeeded by oaks and other deciduous trees, and *vice versa*.

In Bristol County, Massachusetts, in some cases after pines have been cut off, oak, maple, and birch have sprung up abundantly.

In Hancock County, Illinois, oaks have been succeeded by hickories.

At East Hamburg, Erie County, N. Y., a growth of hemlock, elm, and soft maple was succeeded by beech, soft maple, and hard maple, but a great deal more of the last named than any other.—(*C. M. Hampton.*)

---

[1] *Ohio Agricultural Report*, 1872, p. 25.

There can be no doubt but that climatic causes may have some connection with these changes, where they occur to greater extent or in more marked degree,—while the aggressive tendencies of other trees may result from the exceptionally fine conditions of the places where their seed may chance to fall.

It is not unusual to observe in swamps throughout the Northern States, an alternation of growth taking place without human agency, but not without apparent cause. Extensive tracts of tamarack (*Larix americana*) may be seen in Northern Wisconsin that are dying out, and being succeeded by the balsam fir (*Abies balsamea*), which may be probably caused by the partial drainage of the swamps, from the decay or removal of a fallen tree that had obstructed the outlet. Accidents like these, increasing or diminishing the moisture of the soil, may occur from many causes. The construction of beaver-dams have in some cases destroyed large tracts of timber which might very probably be succeeded by other species when the obstruction was removed. Professor Agassiz observed on the south shore of Lake Superior the very dense spruce woods encumbered with fallen birch trunks, as if they had usurped the place of a birch forest.[1]

Mr. Burnet Landreth, in a paper read before the American Forestry Association in September, 1876, mentioned an observation upon the white pine that is worthy of notice:

A gentleman of Virginia, a friend of mine, largely interested in lands, a shipper of timber from the seaboard, therefore not inexperienced, discovered in his forest explorations what, for want of a better term, I should call *a white-pine settlement*, in the dense yellow-pine forests of the northern neck of his State. In the midst of a group of white pines, extending over an area of five or six acres, stood a gigantic individual tree 96 feet high, 8 feet 4 inches in circumference three feet from the ground. There it stood and stands to-day, surrounded by seedlings from 40 feet high down to seedlings a year old, as the boundaries of the settlement are reached, numbering in the whole three or four thousand. Here is a fact which cannot be questioned. A bird of passage had evidently dropped a solitary seed at some period long preceding, which, springing up, had established itself in its new home, far distant from the region where nature had placed its ancestors. The mere fact of a white pine having fixed its abode and prospered in a remote locality is but a trifle; but taken in connection with inferences not to be ignored, its value can hardly be estimated. The proof is made patent that this tree of northern habit thrives equally well with the southern pine (of which there are several species commercially classed as "Carolina") in the latter's native land and under the scorching sun of the South, opens a vista in forest-tree planting which those who look beneath the surface cannot fail to appreciate. *It is the index to future wealth of inconceivable magnitude.*

Mr. Winslow C. Watson, of Port Kent, N. Y., in an article on "Forests, their Influence, Uses, and Reproduction,"[2] notices the changes of character in forests—pines being almost uniformly succeeded by a deciduous wood, and the second growth on the site of a hard-wood forest being as often followed by evergreens and soft-wood trees. He considers the instances as rare and exceptional, in which the primitive forest is succeeded by the same genera of trees. The most careful observation could fix no rules that control these operations of nature. An instance came under his own observation:

In the course of my explorations of Essex County, under the appointment of the State Society, in 1852, I observed many singular manifestations of these caprices. In

[1] *Lake Superior*, p. 77.

[2] *Transactions of New York State Agricultural Society*, 1865, and separately published. pp. 16.

This writer, in presenting these and other instances of a new vegetable growth where a different one had grown before, and noticing the several theories that had been advanced to account for them—such as seeds long buried in the soil, and the like—indulges in a conjecture of his own, still less tenable. We see in these examples no phenomena different from or more difficult to explain than those already mentioned.

the vicinity of the Adirondac Iron Works, a large tract, which had originally borne a heavy forest of hard wood, was at that time exclusively occupied by a growth of small red-cherry trees. It is well known that the native home of the spruce is in a damp, rich soil. At the time I refer to, there was standing in North Elba, upon land from which the original hard-wood forest had been cut off, a thrifty and extensive range of spruce. The soil they occupied was a dry, loamy, and elevated plain, and as I now revert to their appearance I cannot recall the presence among them of a single tree of any other species.

This change of forest-growth was noticed by Mr. Emerson in his *Trees and Shrubs of Massachusetts*, and a cause was suggested in the exhaustion of the nutritious elements required for vigorous growth.

He says:[1]

Nature points out in various ways, and the observation of practical men has almost uniformly confirmed the conclusion to which the philosophical botanist has come from theoretical considerations, that a rotation of crops is as important in the forests as in cultivated fields. A pine forest is often, without the agency of man, succceded by an oak forest, where there were a few oaks previously scattered through the woods to furnish seed. An oak forest is succeeded by one of pine under the same conditions. But it frequently happens that there are not enough trees of the opposite family to seed the ground, in which case a forest will be succeeded by another of the same kind, which, though it will grow, will probably not flourish with the same luxuriance as would one of another family.

Again, after noticing that throughout Massachusetts, in the land left in forest, the soil is thin and poor, the trees must in time perish when deprived of their necessary food, he remarks that this is not necessarily so in the rich intervales. The proper inference would be that, when such a growth has exhausted the elements peculiar to its wants, it should be sown or planted with another kind.

This is clearly indicated in what is constantly going on in the forests, particularly the fact which I have already stated, and which is abundantly confirmed by my correspondents, that a forest of one kind is frequently succeeded by a spontaneous growth of trees of another kind. Mr. P. Sanderson, of East Whately, writes me: "There is an instance on my farm of spruce and hacmetack being succeeded by a spontaneous growth of maple-wood." Instances are also mentioned by him of beech and maple succeeding oak, oaks following pines, and the reverse; hemlock succeeded by white birch in cold places, and by hard maple in warm ones; beech succeeded by maple, elm, &c.; and in fact the occurrence was so common that surprise was expressed at the asking of the question.[2]

SUGGESTIONS FOR THE FUTURE MANAGEMENT OF TIMBER ON THE LANDS BELONGING TO THE GENERAL GOVERNMENT.

Congress has the undoubted right to fix the terms upon which the public lands shall be hereafter conveyed, although questions might arise with regard to cases in which proceedings have been begun for acquiring titles under existing laws. It is earnestly recommended that a modification of these laws be made, under which no sale or grant of agricultural or pastoral lands now treeless shall hereafter be made, except upon condition that a reasonable amount shall be planted in timber within a certain time, and that this proportion of timber shall be thereafter maintained, evidence of the first planting being shown before the title is issued.

It is also within the power of Congress, in the sale or grant of what are now timber lands, to stipulate that a certain portion when cut off shall be protected and allowed to grow up with another crop, and that this proportion of timber shall be thereafter kept up. The title should be issued only upon this condition, the neglect of which by the holder should render it liable to revert to the government. Such a clause of obligation would necessarily follow the title through all its subsequent

[1] *Trees and Shrubs of Massachusetts*, 2d ed. i, 22. [2] *Ib.*, i, 35.

transfers, and should be well understood by those who might in future acquire and own the land.

The custom of selling only the privilege of cutting the timber upon public forest lands, as is done in Canada, is worthy of serious consideration. The fairest way of doing this would doubtless be to require a percentage to be paid upon the lumber or other products removed, either on the pro rata principle of so much per thousand feet, or per cubic foot, or a general percentage of value, as shown by the market prices of the year.

From the bulky nature of these products, and the fact that they must leave the forest by a few channels only, such as rivers, canals, or railroads, the operation could be managed with but little difficulty, and opportunities for evasion would be few. In all shipments certificates of clearance should be required, before acceptance for forwarding by transportation companies or otherwise.

Should such a method of leasing timber privileges be adopted, it would be proper to fix the time that the privilege should continue, and to limit the size of timber allowed to be cut, reserving the small trees for future growth. The title being still held by the government, future sales of timber from time to time on the same land, could be made, and a supply thus maintained, not subject to the caprice of private owners or the fluctuations of markets. Such a system in its simplest forms, implies the necessity of duly authorized agents to prevent depredations, and to collect revenues. For the fullest measure of public utility, it would require skilled agents for managing these forests, bringing them into best condition for yielding the greatest profit, regulating their working, and looking after their reproduction, as is done under the best systems of forest administration in Europe. It is, undoubtedly, good policy to cut timber when fully mature, and where it is needed, and can be sold for its full value; but in every such case at least the same or an equal amount should be reserved for another growth, and if the same area is to be restored, there is great economy in preserving the young trees and small seedlings by forbidding the burning over of such tracts, or the needless injury of such growth. The careless habits of our woodmen render it doubtful whether these dangers could be prevented, unless the instructions accompanying the lease were simple and precise, and their observance insured by inspections from time to time while the clearing was being done.

A system of leasing also necessarily implies a survey and exact definition of boundaries by landmarks well established, and if it be by the acre, and not pro rata, a previous examination by competent and trusty agents would be necessary, with the view of knowing the character and value of the timber leased. But, taking all points into consideration, we do not hesitate to prefer the method of charging a percentage upon the manufactured lumber or upon the measured logs or timber, as less liable to mistake or abuse, and as the surest way of arriving at a result alike fair to both contracting parties.

In the public sales of timber in France, the description and amount of wood to be sold is first ascertained by the forest administration, the minimum price is fixed, and the trees for cutting are marked by the official marking-hammer. The cutting is done by the purchasers within the time and in the manner prescribed by instructions and under the eye of agents who see that the work is properly executed. In Germany, the cutting and removal are generally done by the forest administration, and the products are sold. Whatever excellences these methods may possess, it would probably be difficult for us to adopt either of them at

present, if for no other reason, because we have no agents, or class of persons who could be employed as such, that have received the special training necessary for the due performance of such a duty.

There is another consideration at this point that deserves thoughtful attention. There are few professions in Europe that require more thorough training or careful preliminary practice under competent direction than that of the official forester. A mistake in sowing or planting a field-crop may be corrected the next year, and the worst that can happen is the loss of one season. But in deciding upon the management of a forest, we forecast the interests of a long period—it may be a century or more of time—and an error in judgment, an act from incompetence, may prejudice the results of many years. In fact no person should be intrusted with such a charge unless known to be qualified. It is equally true that no young man would select such a profession unless he knew with some certainty that, upon passing the required examinations and probation, he would be sure of employment through life with a reasonable salary, sufficient to provide for the wants of old age, or, what is equivalent, provision for these wants when his working days are passed.

These inducements are offered in Europe, but cannot be at present or for years to come with us. The aspirant for the State forest service in Europe, once fairly appointed, and sustaining his reputation for capacity and fidelity, has as reasonable a prospect of continuance, as if in the regular military or naval service. He needs only first the privilege of appearing for competitive examination. If he meets the requirements of the school and passes successfully through the course and subsequent probation, in which his ability to apply in practice the precepts of the school are tested, he knows that he will not need the influence of patrons to secure him place in the beginning of his career, or promotion afterward, according to the rules of the service, and as his merits may deserve. If by preference or circumstances he leaves his profession, his education would probably be as useful to him in civil life as that imparted in the military or naval academy, but more particularly for pursuits involving the propagation of trees or the use of forest products. He may become a nurseryman or a private planter, but these employments require capital when carried on extensively, and some years must elapse before a return can be realized. We have as yet no land-holders who give certain employment to professional foresters; no great forests that the owners would undertake to manage according to the rules of the profession. There is, therefore, no inducement for spending years of special study where the chances of employment are precarious, and so long as forestry remains in its present rude and elementary condition among us, there is more to be gained by teaching its general principles to *many* than its thorough details to *a few*.

But the leasing of timber privileges, rules for the proper working, and removal of the products, and attention to the preservation of a young growth, at least by preventing injuries from cattle or depredations of any considerable amount, are matters easily prescribed, and not difficult to enforce. They require no special qualification beyond honesty and a fair business talent, and this system would at least keep in being the forests which will be needed in future, and which may hereafter be managed under systems that we might wish, rather than hope, at present to apply. The system rightly managed could not fail of being more than self-supporting from the first, and might, under favorable conditions, prove a source of revenue,[1] while our forest estates would still remain

[1] The operations of the system of leasing timber privileges on crown lands in the provinces of Ontario and Quebec are shown elsewhere in this report.

public property, and although shorn of their value for the time being, would slowly recover their former condition, and as prices advanced would share in the profits of enhanced value.

It is obvious that such a system of leasing and supervision can best be managed in bodies of timber of considerable extent, rather than in detached parcels. It would be impossible to suggest the location or extent of timber-lands that should be reserved without knowing the present state of sales and grants, and the condition of the remaining public lands. The changes that may have occurred since former surveys would render any dependence upon returns then made, often quite uncertain at the present time, and the probability would be that at any sale made upon previous notice, but without recent exploration, the purchasers would know more as to the condition of the land sold than the government itself with the original field-notes as its guide, and that the advantage would mostly be on the side of the former.

CALCULATIONS OF COST OF GROWING PINE TIMBER—SUGGESTION OF A BILL BY THE HON. C. C. ANDREWS, MINISTER FROM THE UNITED STATES TO SWEDEN, CONCERNING CERTAIN STIPULATIONS THAT SHOULD BE MADE IN THE SALE OF PINE LANDS.[1]

Mr. Sömson, a highly intelligent Norwegian gentleman, who has made a large fortune in the timber trade, informed me some time ago that, according to a calculation which he had made, pine and spruce timber actually costs and is worth much more than the price at which it is sold. His theory is, that an acre of grown timber is worth the sum that the lowest or nominal price of wild land—say $1 an acre—would amount to as an invested capital, drawing, interest at the expiration of the period required for timber to develop. In the report on Swedish forest culture, accompanying my No. 166,[2] it was shown that in the northerly parts of Sweden, two hundred years, —and on poorer soils three hundred years, are required for the pine to grow to good timber. In the south part of the country one hundred years are sufficient. It may be assumed that one hundred and eighty years are required for the growth of pine timber in the northwest part of the United States. Now, $1 invested at 5 per cent. interest per annum will double, say, in twenty years. In forty years it will be $4; in sixty years, $8; in eighty years, $16; in one hundred years, $32; in one hundred and twenty years, $64; in one hundred and forty years, $128; and in one hundred and sixty years, $256. If a thing is worth what under favorable circumstances it costs to produce it, then this last-mentioned sum of $256 represents the value of an acre of land, originally bought at $1, at the time pine timber will have come to maturity upon it, and this without including the charges of taxes on the land. These figures would seem to show that the pine forests of the United States are being, or have been, sold and consumed at a price very much below their actual value.

In years past vast quantities of pine timber in the northwest part of the United States have been stolen from the government, and at the very time the latter was employing agents to guard it. In very many instances, after the timber has been stolen, innocent parties, supposing from the official maps that the land was timbered land, have purchased it of the United States at private entry, at $1.25 per acre. Interest on the purchase money and taxes have in the course of twenty years made such lands cost the owners from $3 to $4 per acre, and yet the land would not now bring 50 cents per acre. Many a man has been kept poor paying taxes on such land. Again timber-lands have been sold off in so large quantities and so rapidly as to glut the timber market.

But a more important fact still is that no means have been taken to promote regrowth. Where hard-wood timber is cut there is always a chance for regrowth by sprouts from the stumps and roots, but with pine and spruce it is otherwise; and where closely growing forests of pine and spruce are cleared without leaving seed trees, the land may remain forever a waste, growing every year more barren.

In the report above referred to it was shown, that the practice in Sweden when cutting pine timber is to leave six to seven seed trees to about each quarter of an acre. After five or six years the seed trees may be cut.

With the hope of at least contributing a little to the agitation of this important subject, I venture to inclose a bill for an act to promote regrowth of pine timber.

[1] This paper was transmitted to the Department of State from Stockholm, September 21, 1874, and a copy has been furnished from that office for use in this report.

[2] *Foreign Relations of the United States*, 1872, p. 641.

A bill for an act to promote the regrowth of pine Timber.

Be it enacted, &c., That where, on any timber land hereafter sold by the United States, pine timber shall be cut, seed trees of pine shall be left standing at a distance from each other of not over seventy feet, measuring from the bodies of the trees, for a period of five years from the time of cutting; but this provision shall not apply to timber land where all the trees are growing at a distance of more than seventy feet from each other, measuring from the bodies of the trees, nor to land cleared for *bona-fide* cultivation or improvement.

SECTION 2. The cutting of pine timber in violation of this act shall cause the title of the legal subdivision of the land on which the cutting occurs to vest in the State or Territory wherein it is situated, the same as if it had been granted to such State or Territory for the support of the public schools.

ENCOURAGEMENT OF FOREST-PLANTING BY OUR STATE GOVERNMENTS.

Many foreign countries, in which there are extensive domains belonging to the government or to local municipalities and public institutions, have established and for long periods have maintained systems of forest-management directly under State control as permanent departments of the Government and necessary incidents to the proper maintenance of the supply of forest products. The details of these systems will be elsewhere in this report more fully noticed. It is sufficient here to say that they are for the most part inapplicable with us, for the reasons that most of our States have no forests or lands on which forests could be grown. Our counties, cities, and towns, are not land-holders, and the landed estates of public corporations are scarcely worth mentioning, or are already so absolutely given that no new conditions could be now imposed. It is true that in some States there are lands granted for specific objects; but these are largely already sold, and questions might arise in case of any attempt to attach new terms in the management of properties already granted absolutely and the titles fully confirmed. Aside from these considerations, the proper care of forests implies the appointment of agents specially educated to the business—and this class of men we do not have among us, and those that may have been educated at schools of forestry abroad would find their experience from foreign examples often inapplicable to the conditions that exist with us. As a rule our climate is dryer than in Europe, and as we approach the treeless belt of the west this circumstance opposes difficulties which methods there effectual would scarcely surmount. We must in these cases work out an experience for ourselves through individual enterprise and by associated effort.

For the sufficient reasons that our State governments do not have lands proper for sylviculture under their control, and that we are as yet wanting in the class of agents that could manage them with best effect, we must, at least for the present, depend upon the owners of the soil to plant and rear the forests of the future. A beginning has already been made through the interest excited in the discussions of agricultural and horticultural societies, and, to some extent, under direct or incidental encouragement of the States. Let us consider some of the ways by which this encouragement can be most effectually applied:

1. A State government may properly offer premiums for the planting of trees—and this can best be done through the agency of agricultural and horticultural societies. A given sum will secure a larger result, if offered in many small prizes, than in a few large ones, and the competition might generally be limited to single counties rather than to larger districts. The classification of premiums should apply to the best plantations of timber of given kinds; to experiments upon different soils; to methods of management; and to the trial of species not native

of the locality, in the hope of finding some that might be found especially suited for cultivation, and for arriving at the best results in their management. In these premiums the highest importance should be attached to the greatest number, if for a single species, or the greatest variety, if on an experiment of acclimatization. In some of the Western States, following the example set by Nebraska, an "Arbor Day" has been designated, which is well so far as it brings a good result; but above all, we should avoid the error of *limiting the premiums to the planting of one day;* they should always be open *for the season*, allowing the competitors to choose their time, as best suited the weather and their own convenience. The appointed day might be stormy, or might be otherwise unfavorable, and the liability of injury from keeping young trees in readiness for the day would often result in losses that might be avoided by immediate planting as soon as received. Moreover if the competition in planting extended through many days, instead of being restricted to one, a vastly greater result would be accomplished.

In the payment of premiums, of course the result should be assured by time, and the prizes should go to those who showed the greatest number of living and promising trees at the end of at least two years. All applicants for premiums should report their methods of management, and the best of these should be published.

In experimenting upon a new species, it is quite important that we know concerning the *failures* as well as the measure of success, since these may hinder others from engaging in an unprofitable enterprise. Premiums should be arranged so as to interest the young in the planting and care of trees. Early impressions are long remembered, and thus imparted, they may carry their influence through life, and be handed down to generations beyond. Prizes might be given for displays of forest products at public fairs, and to best essays on management. If ladies can be interested in these competitive enterprises as applied to ornamental planting and home adornment, a decided benefit will be secured. A display of the beautiful on the lawn, may excite emulation in others, and a spirit of improvement is created and diffused, the refined appreciation thus awakened, extending to tree-culture generally.

2. A State may encourage forest-planting by *exempting from taxation* for a specified time, such cleared lands as may be planted in forest, or by exempting such property from *extra valuation by reason of forest planting.* It may also encourage planting along the highways, by allowing deductions to be made from highway taxes, or by direct allowance of money, according to number of trees planted, assurances of success being first had.

3. It is worth considering whether the State may not properly impose a *tree-tax* analogous to road-taxes, to be satisfied by the planting of trees along the highways, or by the payment of money to be expended in securing their planting. This in certain cases might be justified under the right of eminent domain, by which the government may require a thing to be done where the public welfare demands it. Instances of this appear, in cases where a belt of woodland is needed to intercept the malaria of a swamp, or to arrest drifting sands, or to prevent eroding torrents. Such local benefits should be placed under the control of the local municipalities most affected by them. Of course where the owner of lands is thus required to do, or is prevented from doing, any act that may involve expense, or may lessen values, for the sake of the public good, he should be reasonably paid by those who receive the benefit, whether it accrues to a town, a city, a county, or the State.

4. There can be no doubt but that a great demand upon our forests

might be saved by dispensing with *needless fences*, and legislative provision may be made by which these may be avoided, in requiring the owners of farm-stock to keep them upon their own premises. This is already done in some States, but not in all. It would be found in practice much cheaper to fence cattle *in* than *out*, and pasturage upon the highways imposes, for the benefit of others, an unjust tax upon the owners of land who may wish to cultivate grain in fields adjacent. In the prairie States, farmers have found from necessity, that it is cheaper to tether their domestic animals if few, or to herd them if many, than it is to inclose their range with fences.

5. A State may pass stringent laws for preventing *forest fires*, by imposing heavy penalties for negligence, and by requiring great precautions where fires are necessarily set in or near woodlands. These regulations should apply to the burning of fallow lands or brush, the making of charcoal, and the careless use of fire generally, where danger is possible. Additional restrictions might be laid upon railroad companies, tending to prevent accident by fires along the line of their roads, as elsewhere more fully specified. The destruction by forest fires in some years greatly exceeds the demand for consumption of the whole country, and so far as can be done by vigilance and precaution, enforced by legal measures, nothing should be left undone.

6. In every State, cases may occur in which injuries may arise from sand shifting or drifting snows, the former burying fertile lands and the latter obstructing travel on the highways. Both of these evils may generally be prevented by judicious planting, and laws should be provided under which this might be done at local public expense where needed. The planting of an evergreen screen on the windward side of a road exposed to drifting snow, might be of great and permanent service, and these should be within the power of road-officers to establish and maintain.

7. A State may *aid* institutions of learning in establishing means of instruction in sylviculture, and may *require* this to be done in institutions either wholly under its control, or those receiving appropriations from its treasury. Useful ideas imparted in the normal schools might be carried to the primary schools, and through these agencies the rising generation might, in some degree, be taught the importance of this subject as regards the public welfare as well as private interests generally. The State might encourage the planting of trees as objects of instruction upon the grounds belonging to institutions of learning by offering suitable premiums or by paying a part of the expense. Every collection of trees thus planted should be suitably labeled with the common and scientific names. It might also aid, and in some instances require, the formation of experimental stations, for showing the best methods of planting, or for studying the effects of woodlands upon climate. This should be done, if attempted, under a central direction, with the view of obtaining trustworthy instructions and comparable results, as is now done at public expense in several countries in Europe.

8. A State can cause its forest resources to be explored and its wants and capabilities to be made known, and it can cause useful information upon this subject to be published for the information of its citizens. The State of Iowa has set an admirable example in this by enabling a State society to prepare for distribution an annual pamphlet upon this subject, giving concise and useful information for the guidance of those who might wish to engage in tree-cultnre.

The State could give additional powers to city, town, and village governments, for the planting of parks and the encouragement of other im-

provements in their streets and suburbs, whereby a refining influence would be awakened and diffused in a manner tending to the improvement and enjoyment of its citizens, and to the promotion of tree-culture generally. In order to secure harmony of plan and effect, such plantings should be under the direction of the local governments as fully as the constructions of sidewalks or the pavement of streets. Where they applied to a street, they should be in accordance with the wishes of a majority of the owners of property benefited, and at the expense of the owners of the adjacent premises, without liability of interruption through the caprice or dissent of individual owners. Examples of successful tree-culture, in parks and avenues, cannot fail of having a tendency in favor of the practice generally, and this, if secured, leads to better results in the planting of timber-belts upon farms, and in the improved appearance and condition of the whole country.

A suggestion of management in some degree comparable with European methods, was made by Peter Guillet, in a work on timber-measurement published in 1823. He says:

> Individuals wishing to make the most of their woodlands will find it very profitable to cut their timber by sections, sparing to every acre ten or twelve of the most promising size white oaks or pines, whichsoever the soil will produce best; range the order of their lands so as to cut a section every year. For example, say a man has 200 acres of woodland divided into sections of 10 acres each, then, by cutting one section every year, he would have young timber twenty years old, which makes excellent firewood, and I should say that in common lands wood of twenty years' growth would yield 15 or 20 cords of firewood per acre, besides fencing-timber sufficient to always keep in good repair an inclosure of 200 acres. Then the 10 or 12 trees growing in reserve will, at the end of 80 or 100 years, furnish timber fit to make shipping or staves. Where land has become useless from long cultivation, a little trouble only is necessary to make it productive and profitable to the owner. By inclosing it for a few years and encouraging the growth of the most promising young trees, which will generally spring up spontaneously, all the advantages above described will be derived from it, which is certainly the best way that worn-out or sterile land can be disposed of. Such a course recommended to and adopted by individuals would not only be to their own private gain, but also of great public utility.[1]

STATE LAWS FOR THE ENCOURAGEMENT OF TREE-PLANTING.

The following is not presented as a complete collection of the State laws that have been passed upon the subject of tree-culture and timber protection, but it will be found to include the principal ones in which inducements have been offered for the planting of trees. The laws of all of the States afford remedies against trespass and depredations upon timber-lands, and many of them confer the right of planting trees within the limits of the highways by the owners of adjoining lands. The comparison will present a general idea of the state of public opinion, as expressed in statute laws upon the subject under consideration, and will afford suggestions of value in the preparation of further laws for the promotion of tree-culture.

CALIFORNIA.

By an act approved March 2, 1864, it was declared unlawful to cut or girdle any tree on lands belonging to the State or the United States, so as to remove the bark on more than an eighth part of the circumference, or more than three inches into the wood. The gathering of pitch

[1] *Timber Merchants' Guide*, etc., with numerous colored plates representing the principal pieces of timber used in building a 74-gun ship of the line, in standing trees. By Peter Guillet, l'aîné, "French by birth, American by choice." Baltimore, 1828. 8°. pp. 112.

or other substances discharged from trees thus cut, was to be deemed *prima-facie* evidence of having cut the same. The penalty for thus cutting trees was limited to a $500 fine or 250 days' imprisonment. This act did not apply to timber cut for manufacturing into lumber, or for firewood, tanning, or agricultural or mining purposes, but in these cases the cutting was to be done economically, and not in anticipation of future needs beyond that for immediate use.

AN ACT to encourage the planting and cultivation of shade and fruit trees upon the public roads and highways of this State.—Approved March 30, 1868.

SECTION 1. The Board of Supervisors of any county of this State may by an order of such Board, to be passed at a regular meeting of such Board, and to be entered in the minutes thereof, authorize the planting and cultivation of shade and fruit trees, by persons owning lands in such county upon the public roads and highways adjacent to such lands.

SEC. 2. The Board of Supervisors may, by order entered upon their minutes, designate the roads or highways upon which such trees may be planted, so describing such road by reference to places and boundaries, that the same may be readily ascertained. They shall also, in such order, direct the species of trees to be so planted, their age when planted, their distance from each other, and their position with regard to the traveled road; and also all such other rules and regulations as they shall deem proper to secure the proper planting, growth, and protection of such trees, and also to prevent their obstructing the travel upon such road.

SEC. 3. Whenever any person shall plant upon any public road, in front of land owned by him, shade or fruit trees, in accordance with the provisions of this act, and also of such rules as the Board of Supervisors may prescribe hereunder, such person so planting such trees shall file with the Board of Supervisors of such county a written statement, setting forth therein the road or places upon which such trees are planted, the number and species of trees thus planted, and the time of planting.

SEC. 4. Four years from and after the date of planting such trees, and giving the notice as provided in section third, the person planting such trees, or his legal representative may present to the Board of Supervisors of such county, his statement in writing, verified by the oath of such applicant, setting forth therein the number and species of trees originally planted; when, and by whom planted, or caused to be planted, and the number then living and in a thrifty condition, and for any willful misstatement contained in such report, the party making the same may be prosecuted for the crime of perjury.

SEC. 5. Upon filing such verified statement, the Board of Supervisors of such county shall allow to the party making the same the sum of $1 for each and every tree so planted and growing thriftily, the same to be audited and paid out of the general fund of such county as other claims are allowed, audited, and paid.

SEC. 6. Nothing contained in this act shall be construed to apply to any trees planted before the passage of this act, or unless planted and cultivated as required by the orders of the Board of Supervisors.

SEC. 7. This act shall be in force from and after its passage.

Mr. I. N. Hoag, the secretary of the State Board of Agriculture, in transmitting this act to the several Boards of Supervisors, enumerated the following kinds of trees as hardy, of rapid growth, and suitable for planting, viz:

Black and honey locusts, black, white, and fruiting mulberry, Osage orange, native and eastern black walnut, American chestnut; European, American, and cork-bark elm; maples, tulip-tree; Carolina, Lombardy, and silver-leaf poplar; ash of different kinds; apple, pear, plum, cherry, almond, and fig; Eucalyptus, or Australian blue and red gum; Monterey pine, sugar pine, yellow pine, spruce pine; Norway spruce; balsam fir, Scotch pine, European larch, Monterey cypress, Italian cypress, California redwood, and California laurel.

By an act of the California legislature, approved February 13, 1872, a penalty of not more than $1,000 or a term of imprisonment not more than one year, might be imposed for willfully setting fire to any wooded country or forest belonging to the State or the United States, or to any place where fire would communicate with such forests. The careless

neglect of fires kindled for lawful purposes, through which such accident should happen, was made also punishable in like manner.

An act approved March 13, 1874, forbids the cutting down or stripping off of bark of any tree "over sixteen feet in diameter" in the grove of big trees in the counties of Fresno, Tulare, or Kern, or the destruction of any such trees under a penalty of not less than $50, nor more than $300, or by imprisonment not less than 25 nor more than 150 days, or both fine and imprisonment. One-half of the penalty is to be paid to the informant.

COLORADO.

The new State of Colorado has been the first to recognize in her constitution the duty which it owes to the future in the care of forests, and is the only State in the Union in which a guaranty of this nature is incorporated into the fundamental law.

In Article XVIII of the constitution adopted in convention March 14, 1876, we find the following sections:

SEC. 6. The general assembly shall enact laws in order to prevent the destruction of, and to keep in good preservation the forests upon the lands of the State, or upon lands of the public domain, the control of which shall be conferred by Congress upon the State.

SEC. 7. The general assembly may provide that the increase in the value of private lands, caused by the planting of hedges, orchards, and forests thereon, shall not, for a limited time, to be fixed by law, be taken into account in assessing such lands for taxation.

The constitutional convention that prepared this instrument adopted a memorial, which was presented by Mr. Patterson in the House of Representatives on the 21st of March, 1876, asking for the transfer of the timber-lands of the then Territory to the care and custody of the State, setting forth the reasons therefor as follows:

MEMORIAL.

To the honorable the Senate and House of Representatives of the United States of America in Congress assembled:

The memorial of the convention assembled for the purpose of framing a constitution for the State of Colorado respectfully represents:

That the greatest attention ought to be directed to the preservation and care of those resources upon which the welfare of the people depends. This principle finds an especial application with us as far as our forests are concerned. With the exception of our mountain regions, but little timber is met with anywhere in Colorado. But along the creeks and rivers which cross our prairies we may find now and then a small spot covered with scattered trees and short, useless undergrowth. Our mountains alone contain forests worth the while to be mentioned and considered. But even these, except some valleys, where, indeed, beautiful forests are yet growing, present an alarming spectacle to the close observer. The slopes, ridges, and higher plateaus of the mountains contain but few trees, generally short and twisted from their constant exposure to strong winds. The higher regions, of course, are bare on account of their great elevation. Only the more protected portions of the mountains, valleys, and small parks contain valuable timber. The area of the mountainous portion of Colorado, as far as we can estimate from the best topographical maps and our own knowledge, amounts to about 15,000,000 acres. Of these, 30 per cent. may be considered bare at present, 30 per cent. covered with useless wood, 30 per cent. to contain about twenty-five cords of wood per acre, and 10 per cent. unobjectionable forests. But the rapid increase of our population; the spread of industries, the building of extensive railroads, the reckless devastation of timber in cutting and transporting it, and the frequent fires—mostly caused by carelessness and often raging for months—threaten soon to destroy our forests and expose us to the danger of a wood famine, if some effectual means are not employed to check a further destruction and to remedy, as far as possible, the damage already done. The consequences of such a calamity would be severely felt; thousands of laborers would be thrown out of employment, who had made a living in cutting, transporting, and working up the products of our forests. Saw-mills would have to stop, and smelting-works have to be removed entirely out of our

mountains. Many mines could not be worked at all, on account of want of timber, and thus our main resource of existence—mining—would be severely crippled. Besides, the large capital now invested in machinery would become unprofitable, and still greater sums of money would have to be yearly expended to supply us with the necessary wood for building purposes and machinery. We must not console ourselves with the thought that such a calamity is yet far off. A comparison of the condition of our forests sixteen years ago, when our Territory began to settle up, with that at present, and taking into consideration that there is a geometrically progressing consumption of wood to be anticipated, entitles us to the belief that twenty-five years from now the devastation of our forests will be complete, and that our mountains then will rather have the appearance of enormous ruins than that of an inviting field for human enterprise.

It would be a shame for an intelligent people to look with indifference at such an approaching calamity, and it would be an unpardonable mistake in a wise government not to provide in time, whatever may be the sacrifice, against an evil which, when once it overtakes us, can never afterward be remedied, or at least not for centuries. So far we have referred to the direct results, if we do not protect our forests against devastation; but there are besides, indirectly connected with it, certain evils which still increase the mischief. These are produced by losing the beneficial influences of our forests upon climate and vegetation. A forest, or larger samples of trees and bushes growing rather in close proximity, is, so to say, a magazine of moisture, from which the atmosphere is constantly supplied with this commodity. How great this exhalation of moisture of a forest into the atmosphere must be can easily be concluded by stating that experiments have shown that a single full-grown lime tree is able to exhale twenty tons of water from spring to fall. Further, regular forests keep the soil in which their roots grow in a comparatively loose condition, and thus enable the melting snows and falling rains to easily sink into the ground, and in course of time are gradually given back to the atmosphere by exhalations through the leaves, or run slowly off if there be a surplus through springs into the large water-courses. They also attract the moisture suspended in the air and conveyed there from other parts of the earth by the great atmospheric currents. In short, we may say, forests form natural reservoirs of moisture; fertilize the atmosphere and prevent heavy rains from rushing suddenly down into the valleys and causing floods. They keep up a lasting supply of water in the natural streams, break the force of the winds, and exert generally a most beneficial influence on climate and vegetation, and where irrigation is to be used they may be considered their natural auxiliaries. This is exactly what we want in Colorado, where our climate is so dry that we are obliged to irrigate if we wish to raise crops, and where our pasture regions will become more profitable the more our atmosphere is moistened. If we continue the devastation of our present forests, we will certainly at the same time destroy a great portion of our means to develop our agricultural and pastoral resources; and, taking this together with the above-mentioned dangers arising from actual want of wood, we may well stop and consider how to escape these calamities. It may be, perhaps, not quite out of place here to refer to the experience made in this respect in other countries, as well in ancient as in modern times. The Bible speaks of the cedars of Lebanon as large and beautiful trees; the country around was then thickly settled. At present, according to a late report, only a few dwarfy trees are there to be found, and the adjoining country is a perfect desert, only able to support a few nomadic hordes. Spain, at the time of the Roman republic, was covered with majestic forests, and the Romans built their ships there, and the country was renowned for its fertility. At present, their forests have disappeared to a great extent; agriculture has become of little profit, and stock-raising has taken its place, and a poor, scanty population, about one-third of its former number, now inhabits the peninsula. We read the same of the north coast of Africa, Asia Minor, Persia, Greece, Turkey, and many other countries. Everywhere the fertility of the soil has greatly diminished with the disappearance of the forests, and where once 300,000,000 of people were living we can now hardly count 50,000,000. But more convincing are the experiences of modern times in Russia, France, South Africa, and even some parts of the United States, especially in Ohio and Pennsylvania. Everywhere in these countries the forests were cut down without being replanted, the natural results of which are they now suffer from frequent droughts, floods, and a lower temperature in winter, and a frequent failure of their crops in consequence.

Of all Europe only Germany escaped these evils, and this only by introducing in time a suitable system of forest-culture, which is now brought almost to perfection, and no expense and care are spared to sustain it. Great efforts have been made for some time past all over Europe, outside of Germany, to introduce this system, and even an international forest law is taken into serious contemplation by all sections of Europe. As far as we in Colorado are concerned, we cannot afford to delay any longer to make at least some movement to save our forests and to attempt to extend them as soon as possible even into our plains, if we wish to fully develop our agricultural, pastoral, and mining interests, and to escape the danger of becoming destitute of the

necessary wood for building purposes, fuel, machinery, &c. But we must refer to an obstacle which if not removed would greatly hinder our purpose; this is the circumstance that we do not possess the full control of the forests in Colorado. By far the greatest part of them is in the hands of the Government of the United States. Those small tracts now owned by private persons would hardly, for the present at least, materially interfere with the management we intend to propose. We think it essential, nay, necessary, for the furtherance of our object to acquire not only the exclusive control of all the government forests in our mountains, but also at least one-fourth of all the government lands on our plains to use in future times for forest-culture. This proposal may seem at the first glance as somewhat exorbitant, but we have no doubt, after a little reflection, that it will appear quite proper, nay, even advantageous to all parties concerned. If the forests of Colorado are left as they now are their fate is sealed; they will have disappeared before another generation will have half passed away. There are a great number of cases on record where parties have been prosecuted for cutting timber on government lands; and, although the facts in each case were undeniable and the laws referring to them plain and unmistakable, still no judge or jury can be found or ever will be found in our Territory who will pronounce such trespassing parties guilty and punish them. The reason is simply this: We need the wood and cannot exist without it, and will have it as long as there is any left. We see here that great truth clearly demonstrated, "Need is stronger than right." But with the disappearance of our forests we may as well cease our efforts to progress. Our otherwise immense natural wealth will never be developed to any extent, and progress in any direction cannot be thought of. What would the Government of the United States gain by having the forests of Colorado destroyed? They cannot be sold, and the national government cannot protect them. We alone, who are living here dependent upon them and appreciating their value, are able to save them from destruction and the chain of attendant evils. If we were an old and a wealthy people with a dense population, we could buy the forests; but we are young as a people, and, as in all newly-settled countries, we need our all to build canals, ditches, railroads, factories, schools, and colleges, and fully develop the resources of our mines and virgin soil. Would it not be the wisest policy for the Government of the United States to transfer the control of our forests to the care of the prospective State of Colorado, together with all the lands on our plains needed for the future culture of forest trees? Such a measure seems to us so plain, so just, and advantageous to the nation at large, as well as to ourselves in Colorado, that we venture to propose to Congress to make such a transfer.

It may not be out of place here to mention that however wise and beneficial the present system of disposing of public lands may have been when applied to other States and Territories, still its enforcement in Colorado will be injurious not only to us, but will, if persisted in, bring destruction and calamity upon the entire population of the so-called "Far West." Here the climate is dry, and agriculture is impossible without irrigation, however fertile the soil may be; and if ever the prairie should be redeemed and made the home of a dense population, it can only be effected by a combination of irrigation and forest-culture. Does it not seem to be the duty of the national government to protect our forests from destruction by putting them into the hands of somebody who is able and willing to protect them? And is there a reasonable doubt in the minds of any that those who are the most able to do so are the Territorial and State governments of the West? Congress ought to pass a law that, in countries where the climate is so dry that agriculture cannot be carried on without irrigation, the existing forests should be withdrawn from private entry and put under the control of the respective State or Territorial governments, with such by-laws as will preserve and keep them in a flourishing condition. This convention has already embodied in the constitution of the prospective State of Colorado the following article, namely:

"The general assembly shall enact laws in order to prevent destruction of, and keep in good preservation, the forests upon the lands of the State or upon lands of the public domain, the control of which shall be conferred by Congress upon the State."

In contemplation of the above-stated reasons, this convention respectfully suggests to Congress to put the respective forests and waste forest grounds of all those regions where irrigation has to be used for agricultural purposes under the control of the respective Territorial or State governments.

J. C. WILSON,
President of the Convention.

Attest:

W. W. COULSON,
Secretary.

Bills were introduced at the first session of the State legislature for carrying into effect the intentions of the constitution in respect to timber-planting, but final action was not reached before adjournment.

CONNECTICUT.

Any person or association may, with the written permission of the selectmen of the town in which a highway is situated, recorded in the land-records of such town, set out and protect trees in such highway, by suitable posts and stakes, when said selectmen shall judge that said trees will not interfere with the public travel, or injure the owner of land adjoining such highway; and no such tree, post, or stake shall be removed, except by written order of such selectmen, when necessary for the purpose of repairing or grading such highway, or making it convenient for public travel; but this section shall not affect the power of the authorities of any city or borough to adopt regulations regarding such trees therein.—(*General Statutes of Connecticut*, 1875, p. 233.)

In 1877 provision was made in this State for a report upon forestry, and the Hon. B. G. Northrup visited Europe under a commission for this purpose.

DAKOTA.

Along all public highways of not less than 66 feet in width, the owners, occupants, or claimants of adjoining lands may use and occupy one rod in width of such highway adjoining such lands for the purpose of cultivating the growth of timber and trees thereon: *Provided*, That the same be kept continuously in good order, and under full timber and tree cultivation.

Any person cultivating a hedge upon his land adjoining a public highway, and desiring to fence the same, may place such fence 7 feet over and upon such highway: *Provided*, That it do not obstruct the public travel.—(*Revised Code of Dakota*, 1877, *p.* 148.)

ILLINOIS.

AN ACT to encourage the planting and growing of timber. Approved February 9, 1874. In force July 1, 1874.

SECTION 1. *Be it enacted, &c.*, That it shall be lawful for the Board of Supervisors, or County Commissioners' Court, in any county in this State, to offer a bounty to any person in said county who shall hereafter plant one or more acres of land with forest trees, and properly cultivate the same for three years, any sum not exceeding $10 per annum for three years for each acre so planted and cultivated: *Provided*, That trees so planted shall not be at a greater distance than 10 feet apart each way.

SEC. 2. Any person claiming the bounty under this act, shall make proof before the county clerk that he has complied with section one of this act, and that the trees planted by him are in a healthy and growing condition.

SEC. 3. Upon proof of a compliance with this act, the county clerk shall issue his certificate to the person entitled to the same, setting forth that the provisions of this act have been complied with, and the number of acres so planted.

SEC. 4. The Board of Supervisors, or County Commissioners' Court, desiring to offer the bounty herein provided for, shall do so by resolution, to be made of record, and giving notice in some newspaper published in the county, three weeks prior to the first day of April of each year; said resolution and notice to state the amount of bounty offered for each acre planted and cultivated.

IOWA.

AN ACT to encourage the planting and growing of timber, fruit-trees, and hedges. Approved April 6, 1868.

SECTION 1. *Be it enacted, &c.*, That there shall be exempt from taxation [of] the real and personal property of each tax-payer who shall, within the State of Iowa, plant and suitably cultivate one or more acres of forest trees for timber, the sum of $100 for ten years for each acre so planted and cultivated: *Provided*, That the trees on said land shall not exceed eight feet apart, and shall be kept in a healthy and growing condition.

SEC. 2. That there shall be exempt from taxation [of] the real and personal property of each tax-payer who shall, within the State, plant and suitably cultivate one or more acres of fruit-trees, the sum of $50 for five years for each acre so planted and cultivated: *Provided*, That the trees on said land shall not exceed thirty-three feet apart, and shall be kept in a healthy condition.

SEC. 3. Persons claiming the benefit of such exemption shall, at the time of making the annual assessment, upon showing to the satisfaction of the assessor of the township in which he resides that he has complied with the provisions of sections one and two of

this act, be entitled to have deducted from the valuation of his real or personal property by the said assessor the amount hereinbefore provided, and it is hereby made the duty of said assessor to make returns to the Board of Supervisors of his county of the name of each person claiming exemption, the quantity of lands planted to timber or fruit-trees, and the amount deducted from the valuation of his property.

SEC. 4. If any person claiming exemption under the provisions of this act shall feel himself aggrieved by the decision of the assessor in the rejection of his claim, then the said owner or applicant may apply to the Board of Supervisors of his county, at their meeting in June, to have the same corrected in the same manner as other erroneous assessments.

SEC. 5. The Board of Supervisors of each county in this State is hereby empowered at the June meeting, A. D. 1868, and at their January meeting in each year thereafter, to exempt from taxation, except for State purposes, the real or personal property of each tax-payer who shall, within the county, within such year, plant and suitably cultivate, or having within such year or the two preceding years planted, shall suitably cultivate one or more acres of forest-trees for timber, to an amount not exceeding $500 for each acre: *Provided*, That said board may fix the minimum number of trees which shall be grown on each acre.

SEC. 6. Such Board is also empowered at the same time to make a similar exemption for every half mile of hedge, and for every mile of shade-trees along the public highway, and for every acre of fruit-trees so planted and cultivated, and to establish the rules and regulations in reference to the planting and cultivating of hedges, shade and fruit trees, and the distance at which they shall be planted, which shall be complied with by persons asking such exemption.

SEC. 7. Any person claiming the benefit of such exemption may appear before the Board of Supervisors at any regular meeting, and upon making proof by sworn evidence, showing to the satisfaction of such Board that he has complied with the requirements which entitle him to such exemption, he shall receive from the clerk of the board a certificate stating the amount of the exemption, which shall be received by the county treasurer in satisfaction of the taxes exempted.[1]

SEC. 8. This act, being deemed of immediate importance, shall take effect and be in force from and after its publication in the Iowa State Register and Iowa Homestead, newspapers published at Des Moines, Iowa.

The sixth section of the preceding law was amended February 21, 1872 (chap. 3, laws of the fourteenth general assembly), as follows:

SEC 6. Such board is also empowered at the same time to make a similar exemption for every half mile of hedge and for every mile of shade-trees along a public highway and for every acre of fruit-trees planted and cultivated as an orchard, and to make one-half of such exemption for every quarter of a mile of hedge, and every half mile of shade-trees along the public highways so planted and cultivated, and to establish rules and regulations in reference to the planting and cultivation of hedges, shade and fruit trees, and the distance at which they shall be planted, and which shall be complied with by persons asking such exemption: *Provided*, That under this act, and the act to which this is amendatory, no person shall have to exceed one-half his real estate exempted from taxation: *And provided further*, That the owners or proprietors of nurseries for the growing of forest-trees shall not be entitled to any exemption for any trees grown for sale alone.[2]

KANSAS.

An act was passed by the legislature of Kansas, March 2, 1868, to encourage the growth of forest-trees by offering a bounty of $2 for every acre of prairie land that might be planted within ten years with any kind of forest-trees excepting black locust and successfully grown and cultivated for three years. A like bounty was offered for each half mile of trees planted along any public highway not more than a rod apart, and cultivated and protected three years. The bounty was to continue twenty-five years (commencing three years after planting), if the plantation was kept in growing condition during that time. Proper

---

[1] See amendment following.

[2] The secretary of the State Agricultural Society, in remarking upon this act, says: "The law is too cumbersome. It is loaded down with so many things to do before exemption is made that it is practically a failure. * * * It is submitted that the simplest form of legislation, and one promising the best results, is to offer a direct bounty in cash to the cultivator of a given area of artificial timber. A few years would so thoroughly satisfy every one of the benefit of arboriculture that the bounty would be no longer needed as a stimulus."—(*Report* 1874, p. 26.)

proofs of planting and of condition were to be established, and an annual report was required.[1]

The above was amended February 29, 1872, by requiring the plantation to include at least 160 trees to the acre, and allowing bounties to begin with 1872 and to continue twenty-five years.[2]

This act was repealed March 26, 1874.[3]

By an act approved March 3, 1868, it is provided that if any person shall cut down, injure, or destroy or carry away any tree placed or growing for use, shade, or ornament, or any timber, &c., the party so offending shall pay the injured treble the value of the thing so injured, with costs, and shall be deemed guilty of a misdemeanor, and shall be subject to a fine not exceeding $500.

The general statutes of Kansas (chap. xl), allow owners who may wish to plant a hedge along the highway, to fence in for not more than five years, a strip of the road not more than eight feet from the outer line, except in the corporate limits of cities.

MAINE.

The Maine Board of Agriculture, in January, 1869, appointed a committee, consisting of Mr. Calvin Chamberlain, and Stephen L. Goodale, their secretary, to present to the legislature such suggestions as they might deem important with reference to the expediency of inaugurating a State policy for encouraging the preservation and production of forest-trees, and to call the attention of Congress to the same subject. Their memorial is given in the annual report of the Board for 1869 (pp. 65–85), accompanied by the draught of a bill. The action of the legislature at that session was limited to its being printed for the use of the two Houses and referred to the next legislature. The memorial, in speaking upon the duty of the State in this regard, says:

> Men need to be taught that we have no moral right to follow blindly an instinct that leads only to present personal advantage, regardless of wide-spread future evils as a consequent; that we are but tenants of this beautiful earth, not owners in perpetuity; and that we have no right to injure the inheritance of those who succeed us, but rather a duty to leave it better for our having occupied it our allotted time. Men need to be taught to plant trees, and their children to plant trees and to love them. Owners of poor lands need advice and direction in planting wood upon them, as a crop more hopeful in riches to future heirs than usual expectations from wasted fields. Owners of *good* lands in Maine, or elsewhere, will, in the future, learn that their bleak fields, if judiciously planted with wood to the extent of 40 per cent. of area, will produce on the remaining 60 more in all kinds of crops than the whole now does, or can be made to do under any other possible course of treatment. Lands well sheltered can and do produce winter wheat in Maine as well as in England, or on the new lands at the West. An immediate adoption of shelter to all lands would result, as soon as such shelter could be matured, in the independence of our State from imported grain. We speak confidently, because advisedly, on this point. While the State has manifested a laudable ambition in developing its resources, while it has wisely provided guardians for the fisheries, and a commission on water-power, it has not yet recognized the more important public concern that underlies both those and all other interests. We believe this to be an important public matter that does not lie outside of legitimate legislation. Shall the legislative voice continue silent on the matter of *forests* till the last tree shall be cut, thus insuring dry channels to the *rivers* and the consequent death of the *fishes*? Must the man of Christendom be taught that monarchies alone are competent to guard and preserve physical nature so as to yield its sustenance in a perpetual round? Or shall a professed Republic for once arise from an unaccountable lethargy and assert its force in its determination to protect itself, and make its declaration of intention to have a country in the distant future worth possessing and worth preserving still?

---

[1] *General Statutes of Kansas* (1868), p. 1094.
[2] Chap. 204, *Laws of Kansas* (1872), p. 402.
[3] Chap. 76, *Laws of Kansas* (1874), p. 110.

This action of the State Board of Agriculture was followed, three years after, by the passage of the following law:

AN ACT for the encouragement of the growth of trees. Approved February 20, 1872.

Be it enacted, &c., That any landholder in this State, who shall plant or set apart any cleared lands, or lands from which the primitive forests shall have been removed, for the growth and protection of forest trees, within ten years after the passage of this act, and shall successfully grow and cultivate the same for three years, the trees being not less in number than 2,000 on each acre and well distributed over the same, then, on application of the owner or occupant of such lands, to the assessors of the town in which the same is situated and is so successfully cultivated or set apart to forest trees, and at the same time of such application shall file with said assessors a correct plat of such lands, with description of their location, and setting forth all the facts in relation to the growth and cultivation of said grove of trees or incipient forest, the same shall be exempt from taxation for twenty years thereafter: *Provided*, Such grove or plantation of trees shall during that period be kept alive and in a thriving condition.[1]

MASSACHUSETTS.

Every such society [referring to agricultural societies receiving the bounty of the State] shall annually offer such premiums and encouragement for the raising and preserving of oaks and other forest trees as to them shall seem proper and best adapted to perpetuate, within the State, an adequate supply of ship timbers.—(*General Statutes of Mass.*, chap. 66, sec. 8.)

Ten or more persons in any county, city, or town within the State, who, by agreement in writing, associate for the purpose of encouraging agriculture, horticulture, or for improving and ornamenting the streets and public squares of any city or town by planting and cultivating ornamental trees therein, may become a corporation by such name as they may assume therefor, upon calling their first meeting and being organized in the manner provided in sections ten and eleven of chapter thirty-three; and shall thereupon, during the pleasure of the legislature, have for their purposes all the rights, powers, and privileges given by sections ten to thirteen of said chapter inclusive, and may hold real and personal estate not exceeding ten thousand dollars. (*Ib.*, chap. 66, sec. 17.)

MICHIGAN.

The planting of trees or shrubs in the Highway.

[Amendment to sec. 2, chap. 25, Compiled Laws, approved March 27, 1867.]

SECTION 1. Any person or persons owning or occupying land adjoining any highway not less than three rods wide, may plant or set out trees or shrubs on each side of said highway contiguous to his land; which trees or shrubs shall be set in regular rows at a distance not less than six feet from each other, and within eight feet of the margin of the highway. *Provided*, That in incorporated villages or cities the common council of such cities or villages may fix and determine the distance that such trees shall be set from the margin of the highway therein; and any such person owning or occupying land contiguous to any highway, and who is assessed any highway or poll tax, may cause to be paid of such tax a sum not exceeding twenty-five per cent. for any years, by

[1] The above statute is in substance the first section only of the bill proposed. The remainder of the proposed law allowed owners to plant or set out trees in regular rows on either side of the highway within six feet of the margin, and, if of the evergreen species, not more than six feet apart, and so trimmed as to promise to result in a wind screen against drifting snows. After three years' successful training he was to receive $10 per mile of annual exemption from highway, poll, or other taxes for a period of twenty years, the screen being kept in good condition during this period. It also provided penalties of $5 to $50 for removal or injury of trees thus planted (reserving, however, to town-officers, the right of removal, if deemed an obstruction), and a fine of $1 to $10 for hitching horses or other beasts to trees owned by another, the prosecution being brought by the owner or tenant, or by the surveyor of the highway of the district where the act was done.

planting trees or shrubs in the margin of the highway, in a space not exceeding eight feet in width from the margins of the highway, which sum, when so paid, shall be credited upon his highway or poll tax for that year; and any overseer of the highway may cause a portion, not exceeding ten per cent. of the highway tax in his road district, to be expended in setting out trees or shrubs, in a space not exceeding eight feet in width from the margin of the highway.

2. Any person who shall (except as hereinafter provided) willfully injure, deface, tear, or destroy any tree or shrub thus planted along the margin of the highway, or purposely left there for shade or ornament, shall forfeit a sum not less than $5 nor more than $100 for each offense, which sum may be recovered in any court of competent jurisdiction: *Provided*, That whenever it shall appear to the board of commissioners of highways in any town in this State, that any shade or ornamental trees or shrubs are an obstruction or an injury to any highway, said trees or shrubs may be cut down and removed by order of the aforesaid board of commissioners of highways.

3. Any person who shall negligently or carelessly suffer any horse or other beast driven by him, or any beast belonging to him and lawfully in highway, to break down, destroy, or injure any tree or shrub not his own, standing for use or ornament in any highway, or negligently or willfully, by any other means, shall break down, destroy, or injure any such tree or shrub, shall be subject to an action for damages in a sum not less than $1 nor more than $25 for each offense, to be recovered at the suit of the owner or tenant of the land in front of which such tree or shrub stands, or of the overseer of the highway in whose road district such tree or shrub may be situated.

4. This act shall take effect immediately.

MINNESOTA.

The first act for the direct encouragement of tree-planting in this State was entitled "An act to encourage the planting and growing of timber and shade trees," approved March 6, 1871. It provided an annual bounty of $2 an acre for ten years, commencing three years after planting, and a like bounty for every half mile of trees planted along the highways. This act was further amended February 20, 1873, as follows:

Be it enacted by the legislature of the State of Minnesota:

SECTION 1. That every person planting one acre or more of prairie land, within five years after the passage of this act, with any kind of forest trees, except black locust,[1] and successfully growing and cultivating the same for three years, and every person planting, protecting, and cultivating for three years one-half mile or more of forest trees, along any public highway, said trees to be planted so as to stand not more than one rod apart at the end of three years, and, when planted on each side of any highway, such trees shall not be planted within the four-rod limit of such highway, shall be entitled to receive for ten years thereafter, an annual bounty of two dollars for each acre, and two dollars for each half mile so planted and cultivated, to be paid out of the State treasury; but such bounty shall not be paid any longer than such grove or line of trees is maintained and kept in growing condition.

SEC. 2. Any person wishing to secure the benefit of this act, shall, within three years after planting such grove or line of trees, and annually thereafter, file with the county auditor of the county in which the same is located, a correct plat of the land, describing the section or fraction thereof on which such grove or line of trees has been planted or cultivated, and shall make due proof of such planting and cultivation, as well as of the title to the land, by the oath of the owner and the affidavit of two householders residing in the vicinity, setting forth the facts in relation to the growth and cultivation of the grove or line of trees for which such bounty is demanded. The several county auditors shall annually, on or before the first day of August, forward to the State auditor a certified list of all the lands and tree-planting reported and verified to them in compliance with this act, with the names and post-office address of the respective owners thereof; providing this act shall not apply to any railroad company for planting of trees within two hundred feet of its track for the purpose of snow-fence.

SEC. 3. If the State auditor shall find that the provisions of this act have been duly complied with, he shall issue to the several applicants entitled thereto his warrant upon the State treasurer for the bounty named in the first section, on or before the

[1] This adverse opinion of the value of the black locust is believed by many to be unjust. It has been found, in some sections of the country at least, that the borer in a dense forest will injure only the margin of the plantation. We have, however, been informed of cases in some of the western States, where this rule did not prevail.

first Monday of October in each year: *Provided,* That if the aggregate of the bounty so applied for shall in any one year exceed twenty thousand dollars, it shall be the duty of the State auditor, on the first Monday of October in such year, to equitably distribute twenty thousand dollars, and no greater sum, among the claimants who may be entitled to the aforesaid bounty, and his warrants for such pro rata shall relieve the State from further claims for such year.

SEC. 4. This act shall take effect and be in force from and after its passage.[1]

AN ACT for the protection of shade trees in towns and cities. Approved March 5, 1877.
[Gen. laws of Minnesota, 1877, p. 229.]

SECTION 1. *Be it enacted, &c.,* That, for the purpose of promoting the planting and protection of shade trees in this State, whenever portions of any recorded city or village plat, or portions of any legal additions thereto, are wholly unoccupied, and the streets and alleys lying wholly within or legally belonging and adjoining to such unoccupied parts are not used for public travel, it shall be lawful for the owner or owners thereof, for the purpose of protecting such shade trees as may be set out therein, to fence up and inclose the same for the period of five years from and after the passage of this act, the same as if such land had not been platted and recorded: *Provided, however,* That prior to such fencing of said land embracing streets, the consent of the proper city or village authorities shall be first had and obtained.

SEC. 2. This act shall take effect and be in force from and after its passage.

MISSOURI.

AN ACT to encourage the growth of forest trees. Approved March 25, 1870.

SECTION 1. Every person planting one acre or more of prairie land, within ten years after the passage of this act, with any kind of forest trees except black locust, and the successful growing and cultivating the same for three years, and every person planting, protecting, and cultivating for three years one-quarter of a mile or more of forest trees upon his own land, to be set not more than one rod apart, and to stand at the end of three years not more than two rods apart, shall be entitled to receive for fifteen years, commencing three years after said grove or line of trees has been planted, an annual bounty of two dollars per acre for each acre so planted, and two dollars for each quarter of a mile so planted, to be paid by the county. Said bounty shall not be paid any longer than said grove or line of trees is cultivated, kept alive, and in a growing condition.

SEC. 2. Any person wishing to avail himself of the provisions of this act, shall, within three years after planting said grove or line of trees, file with the clerk of the county court a correct plat of said grove or line of trees, showing on what section said grove or line of trees is situated, attested by his own oath, and the affidavit of at least two householders of the vicinity, setting forth all the facts in relation to the growth and cultivation of said grove or line of trees.

SEC 3. The county clerk shall present said plat and affidavit before the county court, and if the court find from the facts derived from the plat, affidavits, and other sources that section one of this act has been fully complied with, they shall issue a warrant on the county treasurer for the amount found due.

SEC. 4. Such certificate shall be received and taken by the collector of revenue of the county in which the same was given, for county taxes, and such collector shall be allowed credit to the amount of such certificate on behalf of the county.

SEC. 5. The certificates and proofs provided for in this act shall be renewed annually.

SEC. 6. This act shall take effect and be in force from and after its passage.

The above act was amended February 4, 1876, without materially changing its conditions, other than by extending the time to ten years from the date of this act.

NEBRASKA.

The legislature of this State, by an act passed February 12, 1869, provided an exemption of $100 a year for five years on every acre of trees planted and cultivated, provided that the distance apart should not exceed twelve feet, and that they should be kept alive and growing. Persons without titles to real estate but living upon homesteads under

[1] By a singular oversight, no provision was made by law whereby those who had earned these bounties could get their pay, as no money has been appropriated. This neglect has caused complaint, and should be remedied without delay.

the act of Congress, were to be allowed for each acre of timber under this act an exemption of $50 annually for five years.[1]

The constitution of 1875 forbids the exemption of private property from taxation, but contains the following provision:

The legislature may provide that the increased value of lands, by reason of live fences, fruit and forest trees grown and cultivated thereon, shall not be taken into account in the assessment thereof. (Art. ix, sec. 2.)

NEVADA.

The first act passed by this State for the encouragement of tree-planting was dated November 7, 1873, and was limited to five years. It was amended March 5, 1877, and now stands as follows:

SECTION 1. Every person planting one acre or more of land, within ten years after the passage of this act [of 1877] with any kind of forest or shade trees, and successfully growing and cultivating the same for three years, and any person planting, protecting, and cultivating for three years, one-half mile or more of forest or shade trees along any public highway, said trees to be planted so as to stand, at the end of three years, one rod apart, shall be entitled to receive for twenty years, commencing two years after said grove or line of trees has been planted, an annual bounty of ten dollars per acre for each acre so planted, and ten dollars per acre for each half mile so planted, to be paid out of the county treasury of the county in which said grove or line of trees may be situated; such bounty shall not be paid any longer than said grove or line of trees is cultivated and kept alive in growing condition.

SEC. 2. Any persons wishing to avail themselves of the provisions of section one of this act shall,[2] within two years after planting said grove or line of trees, showing on what section or other piece of land said grove or line of trees is situated, attested by his own oath and the affidavit of at least two householders of the vicinity, setting forth all the facts in relation to the growth and cultivation of said grove or line of trees. The county clerk shall lay such plat and affidavit before the Board of County Commissioners, and if they find, from all the evidence, that section one of this act has been fully complied with, shall cause warrants to be issued upon the county treasury of the county for the bounty above provided for.

SEC. 3. The affidavit of the claimant and of at least two householders of his vicinity, showing the growth and condition of such trees, shall be filed each year in the office of the county clerk before the Commissioners shall authorize warrants to be drawn on the county treasury for the bounty for that year: *Provided*, That the provisions of this act shall in no wise apply to willows and cottonwood, planted for the express purpose of protecting the banks of ditches and canals.

SEC. 4. It is hereby provided that the planting of forest and shade trees, as mentioned in this act, shall in no manner add to or increase the taxable value of said land.

SEC. 5. If any person shall cut down, injure, or destroy, or carry away any tree planted or growing for use, or shade, or ornament, or any timber, rails, wood, standing, being, or growing on the land of any other person, the party so offending shall pay to the party injured thrice the value of the property so injured, destroyed, or carried away, and shall be deemed guilty of a misdemeanor, and subject to a fine not exceeding one hundred dollars.[3]

NEW HAMPSHIRE.

Every town shall have full control of the shade-trees situated within the limits of any public street or highway in such town, and shall have full power to make such regulations from time to time as may be deemed necessary for the protection and prseervation of the same.

---

[1] Governor Furnas, in his inaugural message to the legislature, January 10, 1873, called attention to the operation of the law exempting from taxation by reason of tree-planting as tending to become oppressive in some cases. He thought that a more efficient plan could be adopted at much less expense. The act had cost the State at least $200,000 during the past year. He advised its repeal, and the creation of a tree commissioner or State forester, and a law requiring all State and county agricultural organizations to pay a liberal per cent. of the sums received from the public treasury as premiums. He thought that this course would accomplish much more good, and at not a tenth of the expense.

[2] There appears to be an omission of some words at this place. A comparison shows that the language is quoted literally from the statutes.

[3] By an act approved March 3, 1871, a fine of not over $500 may be imposed for each tree cut or removed from lands belonging to the State, or to corporations or persons.

If any owner of real estate desires to move any shade tree or trees situate between the carriage-path and sidewalk, or within the limits of any public street, he shall first obtain leave of the selectmen, or conform to the regulations which the town may have provided relative to shade-trees.

Nothing in the two preceding sections shall be construed to deprive the owner of real estate to the right to plant, rear, and protect any tree between the carriage-path and sidewalk in any public street or highway on which his estate is situate, if it does not interfere with the public travel.—(*General Statutes of New Hampshire*, 1867, p. 92.)

NEW YORK.

All trees standing or lying on land over which any highway shall be laid out shall be for the proper use of the owner or occupant of such land, except such of them as may be requisite to make or repair the highways or bridges on the same land.—(2 R. L., 279, § 28; 31 N. Y., 156.)

Any person owning land adjoining any highway not less than three rods wide may plant or set out trees on the side of such highway contiguous to his land, which trees shall be set in regular rows at a distance of at least six feet from each other. Whoever shall cut down, destroy, or injure any tree that has been or shall be so planted or set out, shall be liable to damages to the owner of such adjoining land.—(*Revised Statutes*, part 1, chap. 16, art. 7.)

By an act passed April 7, 1863, owners of land (except in cities and incorporated villages) might make sidewalks, and plant shade-trees not more than six feet from the outer line of the highway, if not over three rods wide, with one additional foot allowed for every rod of greater width; and might place a railing for their better protection, but not so as to prevent foot-passengers from using the same.—(*Laws of New York*, 1863, p. 151.)

The act of 1863 was amended May 23, 1874, by extending its privileges so as to allow one-fifth of the width of the highway from the central line (if the road be more than three rods wide), but in no case to exceed eleven feet from the outer line. The trees may be protected by posts and one bar, with openings at convenient distances.—(*Edmond's Laws of New York*, ix, 969.)

By an act passed April 26, 1869, the overseers of highways are allowed to abate from the highway-taxes of any land-owner the sum of $1 for every four trees set out along the highways opposite his land; but no row of elms was to be set nearer than seventy feet, nor maples or other forest-trees nearer than fifty feet from each other, except locusts, which might be thirty feet apart. The trees must be set the year before the abatement of tax is claimed, and they must show evidences of living and of being well protected from animals at the time of such demand. The allowance was, however, not to exceed in any year more than one-quarter of the highway-tax, nor was it to apply to trees growing along the roads before the act was passed.—(*Laws of New York*, 1869, i, 701.)

This act was amended May 3, 1870, by allowing fruit-trees to be set at least fifty feet apart.—(*Laws of New York*, 1870, ii, 1363.)

VERMONT.

The laws of this State have not provided for the planting of trees along the highways or otherwise, excepting to affix a penalty of from $5 to $50 for their willful injury or destruction when growing in a highway, public park, common, or burial ground.—(*General Statutes of Vermont*, 1870, p. 943.) They may, however, be removed by the order of the selectmen, if they prove an obstruction or injury to the highway, or

if needed for repair of roads, and they are subject to the owner's control as to placing or removal, but not to obstruct or injure the highway.—(*Ib.*, 674.)

WISCONSIN.

AN ACT to encourage the planting and growth of trees and for the protection thereof. Approved March 4, 1868.

SECTION 1. Every land-owner or possessor of five acres of land, or more, who shall reserve from the natural growth, or shall successfully grow by planting not to exceed one-fifth part thereof in forest trees, in the form of tree-belts, as hereinafter described, shall be entitled to have the land on which such trees grow exempted from taxation from the time the said trees commence to grow, if planted by the owner, until the tree shall reach the height of 12 feet. Whenever the trees shall have attained the height of 12 feet, he shall be entitled to receive an annual bounty of two dollars per acre for each acre so planted or grown as a tree-belt, which bounty shall be allowed him as hereinafter provided; and the certificate therefor shall be received by the collector of taxes assessed on the entire land of which the tree-belt forms a part, as so much cash.

SEC 2. Tree-belts, to be entitled to the benefit of this act, shall be reserved or planted on the west or south sides of each tract of land, and shall not be less than 30 feet wide, but no tree-belt shall exceed one-fifth part of the entire tract of land on which the same is planted: *Provided*, That if the east and north sides of any tract of land, or either of them, be bounded by a public highway or street, then a tree-belt, one rod wide, may be planted next to said highway or street, and the same shall be entitled to all the benefits of this act, although such last mentioned tree-belt shall, with the other tree-belts on the west and south sides, exceed one-fifth part of the whole of said tract of land. The tree-belts may be composed of any or all of the following kinds of trees, or such species thereof as will grow to the height of fifty feet or more, viz: Arbor vitæ, ash, balsam fir, basswood, beech, birch, butternut, cedar, black-cherry, chestnut, coffee-tree, cucumber-tree, elm, hackberry, hemlock, hickory, larch, locust, maple, oak, pine, spruce, tulip-tree, and walnut. All belts shall be of equal width throughout their entire length, and contain not less than eight trees standing at nearly equal distances from each other, on each square rod of land.

SEC. 3. Tree-belts to be entitled to the benefits of this act, for each five acres of land, must be at least thirty feet wide; for each ten acres of land at least sixty feet wide; and for forty square acres at least one hundred feet wide, and must be on two sides of each square tract of land; and all tree-belts owned by the same land-owner must be planted to not exceed one-fourth of a mile apart, or on the west and south sides of every forty square acres of land; and the tree-belts may be divided and planted[1] on any other lines within each forty square acres, by the permission of the assessor.

SEC. 4. Whenever any person, after having applied for and obtained a bounty-certificate for a tree-belt, shall allow such tree-belt to die out by want of culture or otherwise, or shall cut down the same, or shall pasture the same lands with his cattle or animals, or shall so thin out the tree-belt that, in the opinion of the assessor, it shall no longer be entitled to receive the annual bounty hereby offered, or to have the land exempted from taxation, he shall lose all benefit of this act, until it shall again be accepted and certified to by the assessor.

SEC. 5. It shall be the duty of the assessor, upon application of the owner each year, at the time of assessing the personal property in his district, to ascertain by personal examination of all tree-belts for which exemption from taxes or bounties is claimed, and by inquiries whether the belts have been reserved or planted, and are thriftily growing as required by this act; and if he shall be satisfied that they are not so growing, or that the owner has allowed his cattle and animals access to the tree-belts, or that he has cut down or thinned out the trees so as to destroy their capacity as a wind-break, he shall assess the land for taxes, and shall refuse to grant any certificate showing that the owner is entitled to a bounty thereon.

SEC. 6. This act shall take effect and be in force from and after its passage and publication.

AN ACT for the protection of shade-trees. Approved March 4, 1868.

[Chap. 87 General Laws of 1868, §§ 166–168; chap. xix, title vi, Revised Statutes of Wisconsin.]

SECTION 1. Every person whose lands are bounded by any highway or street, or through whose lands any highway or street may run, may cultivate and grow two or more rows of such kinds of trees as commonly grow forty or more feet in height, on either or both sides of said highway or street, which trees may be planted one rod or less apart in the row, leaving a place for the footpath, and within 8 feet of the outer line of said highway or street. And after said rows of trees are grown as aforesaid to

[1] The words "*or reserved*" added by amendment of chap. 138, *Laws of* 1871.

the height of 12 feet from the ground, the owner may give notice to the officer having the care and charge of said highway or street, that he claims the benefit of this act for the growing of shade-trees; and, thereupon, the officer shall make a personal examination of the rows of trees, and if, on such examination, he shall find that the owner has grown or planted the trees, and that they are growing thriftily, he shall give the owner of said land and trees a certificate showing that he accepts the said rows of trees as shade-trees of said highway or street, and thereupon the said trees shall be protected as public property; but the title to the trees and any fruit they may produce, shall remain the property of the owner of the land.

Sec. 2. The person receiving the certificate aforesaid, shall be entitled to receive an annual bounty for the growing of public shade-trees, at the rate of two cents for each rod of shade-trees on a side of the road, or four cents for the length of the highway where trees are planted on both sides thereof and grown as aforesaid, which said amount of bounty shall be allowed to the person holding said certificate, upon the highway taxes assessed upon the same lands.

Sec. 3. If any person shall, by himself or servant, cut down, break, girdle, bruise, mar the bark, or in any manner injure any public or private shade-tree, or shall hitch any horse or animal to any public or private shade-tree growing on the side of the highway or street, or shall allow any animal under his control to break, mar, or do damage to any shade-tree standing in the line of the highway or street, such person shall be liable to pay the sum of five dollars for every shade-tree which is cut down, broken, girdled, bruised, marred, or injured, or to which any horse or animal is hitched, or which shall be broken, marred, or damaged by any animal under his control, which sum shall be collected by the officer having charge of the highway or street on the side of which the tree so damaged shall stand or be growing, in an action of trespass, and which money when collected shall constitute part of the highway fund in the hands of the officer and be used accordingly; and the person doing or allowing the committing of such damage shall be liable further to the owner of the land for all damage he may sustain, the same as if the public had no interest in said shade-trees. Every officer having charge of the highways or streets, who shall cut down, destroy, or damage any tree planted or grown as aforesaid for a shade-tree within 8 feet of the outer line of the highway or street, or shall order or permit the same to be done by his workmen, shall be personally liable, the same as any other person, under the provisions of this section. This section shall not prohibit the owner of the land from cutting any dead or decaying tree for his own use: *Provided*, He shall immediately plant another tree to take the place of the shade-tree cut down.

Sec. 4. This act shall take effect and be in force from and after its passage and publication.

TIMBER-MARKS.

Throughout Europe the *marteau* (marking-hammer) is used by the state agents for marking trees to be reserved when sales are made of a portion of the growth on a given tract of land. It is a light, long-handled hatchet, with a cutting-blade on one side for smoothing off the rough bark, and some design, usually the initials of the owner or other symbol of ownership, in relief on the head. Its use is very ancient, being found in the older ordinances for the management of woodlands, and it is often used by the purchasers to mark the trees they have bought for cutting. Formerly, in France, the custody and use of these instruments, bearing the administration mark, were assigned to special agents, regularly organized and officered by a chief. Now the state *marteaux* are in France intrusted to agents of the forest service. They are kept in boxes having two keys, and can only be used in the presence of two agents. This instrument has come to be used as the symbol of the forester's profession, like the anchor with the sailor, or the pick with the miner.

Analogous to this is the marking-hammer everywhere in use among American lumbermen, for designating their logs when floated in streams and sorted in booms; and in all the States where this interest is prominent, laws have been enacted for the registration of these marks in offices of town or county record. These laws provide penalties for counterfeiting these marks, and make it criminal to appropriate timber thus marked.

The Dominion Government in Canada has provided by law for the

registration of timber-marks at a central office, and for the issue of certificates of registry as a further protection to the owners, just as copy-rights and trade-marks are protected in the United States.[1] Such a law deserves the attention of Congress, because a river used for lumber purposes may form the boundary between States, like the Menomonee—or timber may be rafted from one State to mills in another, or may escape from booms and be found in other States. In these cases, protection to the owners, is obviously within the province of national laws, and a duty which the United States owes to its citizens.

BEQUESTS FOR THE PROMOTION OF SYLVICULTURE.

The Michaux Legacies in America.

Few names, among European botanists, deserve more honorable notice, in connection with American forestry, than that of Michaux. Of this name there were two, who gave special attention to our forest botany, and left permanent records of their labors.[2] The younger of these, as a crowning act of his life, provided in his will for two bequests, from which we may reasonably expect a most honorable and useful result.[3]

---

[1] The number of timber-marks registered and certified in Canada during eight years commencing in 1870, was 525. The act under which these entries were made was assented to May 12, 1870, and obliges all persons using log-marks to file a description in the office of the Minister of Agriculture, under a penalty of $50 for neglect. The fees are $2 at entry, $1 for recording an assignment, and 50 cents for a copy of the record.

[2] ANDRÉ MICHAUX (born in 1746) came to America in October, 1785, and during the nine years that he remained here, traveled extensively in the Middle, Southern, and Western States, and northward toward Hudson's Bay, procuring trees for the establishment at Rambouillet, in France, to which he sent 60,000 stocks. The French revolution sadly deranged his plans, and almost neutralized his labors.

In 1801 he published, in Paris, a folio volume with 36 plates, entitled "*Histoire des Chênes de l'Amérique, oū descriptions et figures de toutes les espèces et variétés d'Amérique Septentrionale, considéres sous les rapports de la botanique de leur culture et de leur usage.*"

In 1803 there was published in his name, at Paris, in 2 volumes, 8°, a work entitled "*Flora Borealis-Americana, sistens caracteres plantarum quas in America Septentrionali collegït et detexit,*" with 51 plates. The author had set out on an expedition to New Holland in 1800, and died in Madagascar in 1802, before this work was issued.

ANDRÉ FRANÇOIS MICHAUX, son of the preceding, was born in 1770, and died in Paris October 23 1855. Having resided and traveled in this country several years, he published, in Paris, in 1805, an octavo tract entitied "*Memoire sur la naturalisation des arbres Forestiers de l'Amérique Septentrionale,*" and the year previous, a volume of travels in Ohio, Kentucky, and Tennessee, in French. The latter was translated into English and published in London in 1805.

In 1810 he published, at Paris, in 3 volumes, a magnificent work, entitled "*Histoire des Arbres Forestiers de l'Amérique Septentrionale, considéres principalement sous les rapports de leur usages dans les Arts et de leur introduction dans le Commerce.*"

In the same year appeared the "*Histoire des Pins et des Sapins de l'Amérique Septentrionale.*" 4to. In 1819 he published, in Paris, in 3 volumes, the "*North American Sylva: A Description of the Forest Trees of the United States, Canada, and Nova Scotia, with a description of the Most Useful European Forest Trees,*" translated from French by Augustus L. Hillhouse. This has since been published at New Harmony, in Indiana, and at Philadelphia, from the original engraved plates.

[3] In his will, dated September 4, 1855, M. A. F. Michaux, made the following provision: "Wishing to recognize the services and good reception and the cordial hospitality which my father and myself, together and separately, have received during our long and often perilous travels in all the extent of the United States, as a mark of my lively gratitude, and also to contribute in that country to the extension and progress of agriculture, and more especially of sylviculture, in the United States, I give and bequeath to the American Philosophical Society of Philadelphia, of which I have the honor to be a member, the sum of $12,000 (at 5.40 the dollar, 64,800 francs). I give and bequeath to the Society of Agriculture and Arts in the State of Massachusetts, in which I have the honor to be a member, the sum of $8,000 (at 5.40 the dollar, is 43,200), these two sums together making 180,000 francs, or again $20,000. I give and bequeath the

One of these, (to the American Philosophical Society), still remains invested in French funds, and by an agreement with the commissioners of Fairmount Park, a grove of oaks is to be established there, which is to bear the name of "The Michaux Grove," and in which there is to be planted two oaks of every species that will endure the climate. The surplus of the fund, is to be devoted to the cultivation of oaks of every kind that can be reared in the park nursery, which, to the extent of two of each kind, are to be hereafter distributed to other public parks in the United States, under regulations to be hereafter prescribed. The site selected is in a central portion of Fairmount Park, westward of the Schuylkill, the soil being thought sufficiently varied there to accommodate the different requirements of these trees. Upon this portion, in May, 1876, seventeen species of the *Quercus* were already growing, and some of them in their native state, and already a century old.[1]

The portion of the legacy going to Massachusetts has been invested in that State, and the society that is the legal representative of the trust has, during the past three years, granted $1,500 annually to the botanical garden of Harvard University, and, in addition, in 1876, gave $1,000 to the Arnold Arboretum of the same institution. It has also caused to be printed and distributed 10,000 copies of a pamphlet on forest-culture.

Bussey Institution and Arnold Arboretum, Roxbury, Mass.

Mr. Benjamin Bussey, of Roxbury, Mass., in a will made July 30, 1835, provided for a school of agriculture and horticulture as a department of Harvard College. The trustees, in May, 1861, transferred $413,290.69, besides the Woodland Hill estate, for this object. In the spring of 1870 the establishment of the proposed school was begun, the income being then $38,187 and the accumulated fund $75,076.94.

In the spring of 1872, the president and fellows received a gift of $100,000 from the trustees under the will of the late James Arnold, of New Bedford, Mass., for the purpose of establishing in the Bussey Institution a professorship of tree-culture, and creating and maintaining on the Bussey estate an arboretum that should ultimately contain, as far as practicable, all the trees, shrubs, and herbaceous plants, either indigenous or exotic, that can be raised in the open air at West Roxbury.

---

sole ownership to these two above said societies, and the usufruct to my aforesaid wife for her life."

This bequest did not become available until 1870. In a will subsequently revoked, Michaux had suggested the purchase of land and the planting of trees. He doubtless intended the exhibition of many kinds, and a center of distribution for trees and fruits. (*Eli K. Price*, in a paper on Sylviculture, read before the Am. Phil. Soc. November 16 and December 7, 1877.)

[1] The society, in 1876, issued an appeal, which we deem worthy of favorable notice. It is as follows:

"*Trees for the Fairmount Park.*

"This park is in the earliest stage of its formation. A principal feature of its beauty must consist of trees planted in manner to form pleasing landscapes, and in trees planted singly, in groups, and groves. The commissioners desire to also add a botanical interest to the park, by having in it every tree that will stand our climate. To promote this object, and duly to honor the name of Michaux, father and son, the American Philosophical Society have devoted half the income of the legacy left by the son to the society, of about $300 per annum. This has been applied toward the planting of the Michaux grove of oaks, and to importing and planting in our nurseries many varieties of oaks. The announcement of these facts is now made, during the holding of the Centennial International Exhibition, as an auspicious occasion to invite contributions of trees, acorns, and seeds from all parts of the world, and from all persons who love the beautiful in landscape, and to promote botanical science.

"Communications may be made to Eli K. Price, 709 Walnut street, Philadelphia, chairman of committee on trees and nurseries in the park; chairman of committee on Michaux Fund in American Philosophical Society."

We deem it proper to mention, that the idea of making this bequest was suggested to Mr. Arnold by his intimate friend, Mr. George B. Emerson, of Boston whose earnest devotion to the interests of forestry has not for many years allowed an opportunity for its advancement to pass unimproved. The trust was left altogether at Mr. Emerson's control, and when finally conveyed to the corporation of Harvard College, it had increased under his judicious management, largely beyond its original amount.

At least two-thirds of the income of the fund is to be accumulated until the fund amounts to at least $150,000 and the Bussey estate (Woodland Hill), in West Roxbury, passes completely into the hands of the president and fellows of Harvard College.

A part of the estate has been specified as the site of the arboretum, in the indenture which defines the objects and terms of this gift. This portion contains about 137 acres, and is the finest part of the whole estate, as regards variety of its soils, the beauty and variety of the trees already growing upon it, and the lay of the land. It is probable that the grounds will in future be laid out as an open public park, with suitable walks and roadways.[1]

A TASTE FOR RURAL ORNAMENT—ASSOCIATIONS FOR VILLAGE IMPROVEMENT.

No one can doubt but that a realization of the advantages of tree-planting may be greatly promoted through the influence of associations formed for town and village improvement, especially where these enterprises include the premises connected with schools, and where the labors interest the young. An appreciation of the beauties of nature will tend to such measures as will best secure their presence. An example of unusual success, may lead to imitation; and thus extending from one place to another, and from villages to farms, homesteads, and rural dwellings—the general result cannot fail of largely increasing the amount of planting in a country, and of enhancing the enjoyment of the inhabitants among whom this taste for rural ornament prevails. The tendencies of such emulation have been thus noticed by a zealous laborer in this field of useful public service:

> The influence of village improvement in cultivating the taste, developing town pride and public spirit, promoting sympathy with nature, leading to the beautifying of the home, and thus binding the heart of childhood with stronger ties to the homestead, and checking excessive passion for city life, suggests the educational bearings of this subject. A beautiful village is itself an educator to all its youth—for the child's surroundings influence his character.[2]

In many villages throughout the country, the stranger cannot fail of being impressed with a sense of home comfort, sociability, and kindness which the place presents at first sight, and this impression is often confirmed upon nearer view, as he gets more fully acquainted. This feeling is not due to fine houses nor wide and well-paved streets; for what would be more cheerless than such houses or streets unless embellished with trees? It is rather due to the general effect of well-kept avenues of shade-trees, smooth lawns, and tastefully-arranged vines and shrubbery. It is especially improved if the object of admiration is a public park or other ground, in which the care does not depend upon individ-

---

[1] *Bulletin of the Bussey Institution*, i, pp. 295, 455.

[2] Hon. B. G. Northrop, secretary of Board of Education of Connecticut, in his Report of 1875, p. 118. This gentleman, by lecturing and writing, has done much toward promoting a spirit of rural improvement. His reports for 1869, 1875 and 1876, contain valuable articles upon this subject.

ual taste, but upon a prevailing sense of culture and refinement among the citizens, which finds expression in the acts of their public officers, who are chosen to represent their taste in the execution of ornamental improvements, as well as to discharge the common duties of their office.

Among the old towns and villages of New England, there are many that are conspicuous on account of the splendid avenues of trees that line their streets and shade ancestral homes. One of these places is Stockbridge, Mass., which owes its beauty to the "Laurel Hill Association," formed long ago for improving a village park, and from this, the cemetery, public streets, and neighborhood generally. The citizens living along the streets improved, were encouraged to put their premises in tasteful condition, and in keeping them so. The progress of the work is pleasantly described by the Rev. N. P. Eggleston, in a paper written for the New York Tribune:

> Next followed the planting of trees by the roadside wherever trees were lacking. The children, sometimes disposed in their thoughtlessness to treat young trees too rudely, were brought in as helpers of the association, while at the same time put under a beneficial culture for themselves. Any boy who would undertake to watch and care for a particular tree for two years, was rewarded by having the tree called by his name. Other children were paid for all the loose papers and other unsightly things which they would pick up and remove from the streets. Gradually the work of the association extended. It soon took in hand the streets connected with the main street. Year by year it pushed out walks from the center of the village toward its outer borders; year by year it extended its line of trees in the same manner; and year by year there has been a marked improvement in the aspect of the village. Little by little, and in many nameless ways, the houses and lawns, the door-yards and farms have come to wear a look of neatness and intelligent, tasteful care that make the Stockbridge of to-day quite a different place from what it was twenty years ago. Travelers passing through it are apt to speak of it with admiration as a finished place, and, compared with even most of our New England villages, it has such a look; but the Laurel Hill Association does not consider its home finished nor its own work completed. Committees are even now conning plans for further improvements. By itself, or by suggestions and stimulations offered to others, the association is aiming at the culture of the village people through other agencies than those of outward and physical adornment. It fosters libraries, reading-rooms, and other places of resort, where innocent and healthful games, music, and conversation, will tend to promote the social feeling, and lessen vice by removing some of its causes.

In no way can village improvement be so effectually secured as by association, affording a ready means for concert of action and unity of effect. The following form has been suggested as proper for this object,[1] and it is here given with the remark that it might be modified in some cases to meet the wants of local circumstances, and extended to meet other requirements of public utility as might be found proper in certain cases.

Form of Constitution for a Village Improvement Association.

ARTICLE I. This association shall be called "The Village Improvement Association of ———."

ART. II. The object of this association shall be to improve and ornament the streets and public grounds of the village by planting and cultivating trees; establishing and maintaining walks; grading and draining roadways; establishing and protecting good grass plots and borders in the streets and public squares; securing a proper public supply of water, establishing and maintaining such sewerage as shall be needed for the best sanitary condition of the village; providing public fountains and drinking-troughs; breaking out paths through the snow; lighting the streets; encouraging the formation of a library and reading-room; and generally doing whatever may tend to the improvement of the village as a place of residence.

ART. III. The officers of this association shall be a president, two vice-presidents, a secretary, and a treasurer, who shall constitute the executive committee. These offi-

[1] This form is copied from an article by George E. Waring, jr., of Providence, R. I., published in *Scribner's Monthly* for May, 1877, upon the subject of Village Improvement Associations.

cers shall be elected at the annual meeting, and shall hold their offices until their successors shall have been elected.

ART. IV. It shall be the duty of the president, and, in his absence, of the senior vice-president, to preside at all meetings of the association, and to carry out all orders of the executive committee.

ART. V. It shall be the duty of the secretary to keep a correct and careful record of all proceedings of the association, and of the executive committee, in a book suitable for their preservation; to give notice of all meetings of the association and of the executive committee; to make all publications, and to give all public and private notices ordered by the executive committee, and to attend to all the correspondence of the association.

ART. VI. It shall be the duty of the treasurer to keep the funds of the association, and to make such disbursements as may be ordered by the executive committee.

ART. VII. It shall be the duty of the executive committee to manage all the affairs of the association, to employ all laborers, to make all contracts, to expend all moneys, and generally to direct and superintend all improvements which, in their discretion, and with the means at their command, will best serve the public interests. The executive committee shall hold a meeting at least once in each month, and as much oftener as they may deem expedient. The executive committee shall have power to institute premiums to be awarded for planting and protecting ornamental trees, and for doing such other acts as may seem to them worthy of such encouragement. They shall also encourage frequent public meetings of the association and of citizens generally, both with a view to maintain an interest in their work, and for the general encouragement of the habit of meeting for discussion and amusement.

ART. VIII. Three members of the executive committee present at any meeting shall constitute a quorum for transacting business, and the vote of a majority of those present shall be binding on the association.

ART. IX. No debt shall be contracted by the executive committee beyond the amount of available funds within their control to pay it, and no member of this association shall be liable for any debt of the association beyond the amount of his or her subscription.

ART. X. Every person over fourteen years of age who shall plant and protect a tree under the direction of the executive committee, or who shall pay the sum of one dollar annually and shall obligate him or herself to pay the same for three years, shall be a member of this association; and every child under fourteen years of age who shall pay or shall become obligated to pay as before the sum of twenty-five cents annually for three years, shall be a member of this association.

ART. XI. The payment of ten dollars annually for three years, or of twenty-five dollars in one sum, shall constitute a person a member of this association for life.

ART. XII. The autograph signatures of all members of the association shall be preserved in a book suitable for that purpose.

ART. XIII. An annual meeting of the association shall be held, at such place as the executive committee may direct, on the fourth Wednesday of August, at 2 o'clock p. m. Notice of such meeting shall be posted on each of the churches and at the post-office at least seven days prior to the time of holding said meetings, and a written notice shall be sent to all non-resident members. Other meetings of the association may be called by the executive committee on seven days' notice as above prescribed.

ART. XIV. At the annual meeting the executive committee shall report the amount of money received during the year, and the source from which it has been received; the amount of money expended during the year, and the objects for which it has been expended; the number of trees planted at the cost of the association; the number planted by individuals, with the location, the kind of tree, and the name of the planter; and, generally, all of the acts of the committee. This report shall be entered on the record of the association.

ART. XV. Any person who shall plant a tree under the direction of the executive committee, and shall protect it for five years, shall be entitled to have such tree known forever by his or her name.

ART. XVI. This constitution may be amended by the executive committee, with the approval of the majority of the members present, at any annual meeting of the association, or any special meeting, the notice of which shall have been accompanied by a copy of the proposed amendment, with the statement that the amendment is to be voted on at such meeting.

It is obvious that attractive plantations of parks and public grounds in towns and villages must become objects for imitation of greater or less extent, as fashions spread from one example to another, and that they may serve as nuclei of forest culture. It would be still more gratifying should they become a subject of emulation between neighboring villages, and more especially if this rivalry aimed at the production

of natural and picturesque effects, rather than costly display. A scrap of rustic woodland, with its little waterfall and wild forest flowers, close by the beaten thoroughfare and busy mart of a crowded city, would doubtless give more real enjoyment to its citizens than sculptured marble fountains and elaborate decorations of art.

A rural art society was formed in the village of Clinton, Oneida County, New York,—the seat of Hamilton College, in 1854, upon the suggestion of a gentleman from Stockbridge, Mass., and partly upon the plan of the association already mentioned as existing in that place. The society invites to its membership all citizens who are interested in horticulture, pomology, rural embellishment, and, in short, in whatever pertains to the material improvement of the town. Among its present members are most of the college faculty, physicians, clergymen, farmers, and business men. And among its results are a village park, planted and inclosed with a substantial hedge, the establishment of a new rural cemetery, laid out and embellished in an attractive manner, a girdle of evergreens around the old abandoned cemetery, and a marked improvement everywhere in the laying out and planting of private grounds. It does not undertake to do work outside of its legitimate sphere, by seeking to promote the cause of education, or morals, or religion, yet, within the bounds of usefulness assigned, it has done and is doing good service. Topics for discussion are assigned from month to month, and those presenting them are expected to prepare themselves for stating the points under consideration, either in writing or orally. The subjects are varied, and the information elicited by the statement and comparison of views is of much practical interest. Not the least important feature of the society is its social element, the supper-table being a bond of union whose strength has been tried and found great. A pleasant writer in describing this society very justly remarks: "It seems impossible for those who so frequently enjoy each other's hospitality not to become attached to one another and to the society there represented." It has now worked for more than twenty years, and so well that its members would scarcely be willing to let it suspend its operations, nor suffer any essential changes to be made in the organization.

The city of Tuscaloosa, Ala., is sometimes called the "*Druid City*," or "*The City of Oaks*," on account of the fine avenues of the water-oak planted in a central line and along the sides of the streets. This planting was begun in 1837, by Mr. Thomas Maxwell, who set the example upon one block, and induced the authorities to adopt it in every street in the city.[1]

The city of Cleveland has acquired the title of the "*Forest City*," on account of shade-trees planted in the streets and public grounds, most of them within twenty-five years. This was brought about by public opinion, cultivated by the example of the late Leonard Case and a few other large owners of city lots.[2]

---

[1] *Tuscaloosa: The Origin of its Name, its History, etc.*, p. 80.

[2] An elm set out by him in 1824, still thrives near the southwest corner of the post-office. Its girth 2 feet above the pavement is 7 feet, and consequently its diameter is 2 feet 5 inches. In 1836 the Hon. John W. Allen, John M. Sterling, and the late Charles M. Giddings planted native trees in front of lots in which they were interested. By their exertions the village corporation authorized the same to be done in the northeast quarter of the public square, and in 1839–'40 in other parts of it, under the direction of John Wills. These trees are principally elms, and now, after a life of thirty-five or forty years, are from $1\frac{1}{2}$ to 2 feet in diameter. By observations upon nineteen cultivated trees, whose age was known, the average annual increase in diameter was about two-thirds of an inch, or the annual layer about a third of an inch.—(*Col. Charles Whittlesey.*)

CONNECTION BETWEEN FORESTS AND CLIMATE.

The reciprocal influences that operate between woodlands and climate, appear to indicate a close relation between them. It is observed that certain consequences follow the clearing off of forests, which can scarcely be otherwise regarded than as a direct effect, such as the diminution of rivers and the drying up of streams and springs. Other effects, scarcely less certain, are seen in the occurrence of destructive floods, and of unseasonable and prolonged droughts, with other vicissitudes of climate which it is alleged did not occur when the country was covered with forests. These appear to have been brought about by their removal, and might, in a great degree, be alleviated by the restoration of woodlands to a degree consistent with our best agricultural interests.

On the other hand, there are many facts tending to show, that the presence or absence, and the character of forests, are the effect of climate; and that their cultivation generally, or the planting of particular species, is closely dependent upon it. These conditions of climate should be understood before forest-cultivation is attempted. It is also to be noticed that differences of opinion have been expressed among men of science, as to the extent of influence that forests exert upon the climate, and it is quite probable that the advocates of extreme theories may have erred on both sides. But where principles depend upon facts that may be settled by observation, there should be no differences of opinion; and as there is no fact in this subject that may not be verified or disproved, the existence of such differences only shows the want of accepted evidence derived from trustworthy records.

It is less than ten years, since scientific observations have been undertaken in Europe, with the view of settling these points by carefully noting from instrumental indications the actual conditions of the atmosphere in the forests as compared with the open fields, and in forests of one kind as compared with another; and until the present day, we have no observations upon this subject at any point on the American continent that could afford aid by present comparison with these European records, or by reference back from any that may be hereafter established.

Before presenting any of the results thus far obtained at the stations above mentioned, or the methods followed in obtaining them, it may be proper to briefly state such facts as are already well proved, and generally admitted, concerning our atmosphere, in reference more particularly to its temperature, and humidity, as they affect, or as they are affected by, forest growth.

THE ATMOSPHERE—ITS COMPONENT PARTS—AQUEOUS VAPOR.

The atmosphere which surrounds the earth, becomes rarer as we ascend, and at about the height of 45 miles will, from extreme tenuity, not sensibly refract light. Its weight, as shown by the fluctuations of the barometer, is constantly changing over a given place, being subject to variations dependent upon the daily and annual revolutions of the earth, and to the progress of storms; and as these come to be known, they afford our most certain indications of approaching changes in the weather. The average weight of the atmosphere at sea-level, is about equal to that of a column of mercury 30 inches in height, or 15 pounds to the square inch, or about a ton (2,160 pounds), to a square foot. It is

mainly composed of nitrogen and oxygen gases, in the proportion of about 4 to 1 by volume—not chemically united, but each equally diffused, as it would exist if alone. The former has comparatively few affinities, and is not a common element in plants, while the latter is invariably found in all vegetable and animal organizations—is essential to combustion and to life, and as an oxide of metallic bases and a constituent of air and water, it is the most abundant element known.

There is also always present a perceptible amount of carbonic-acid gas, and a variable amount of aqueous vapor. All of these, obey the laws common to all gases, expanding when heated, and contracting when cooled. Expansion, by diminishing the weight of a given volume, gives it a tendency to rise, when displaced by other volumes of greater density. The unequal warming of portions of the earth's surface by solar heat, the earth's rotation, the approach and passage of areas of high or low barometer, and other influences, cause winds, which become the means of carrying over the land the vapor raised from the sea. Wherever these vapors, whether raised from the sea or other bodies of water, or from the earth, condense in sufficient falls of rain, we generally find the earth's surface in a state of nature covered with forests; but where the winds are deprived of their moisture by passing over mountains, or from other causes, no rains fall, and we have arid deserts.

Carbonic-acid gas was probably a more abundant element in the atmosphere in the early geological ages than at present, as vast quantities are found fixed by chemical affinities in the mineral carbonates, more particularly of lime, (forming immense masses of limestone, chalk, and marbles), and in beds of mineral coal. In the former of these the carbonic acid has been largely fixed through the agency of animal life; in the latter it is the result of a luxuriant vegetable growth, at a geological period when the temperature of the earth was much greater, and the amount of carbonic-acid gas relatively much more abundant than at present. This proportion in the present atmosphere, is variously estimated at from one-thousandth to four ten-thousandths part of the air by weight; in other words, there are from 18.8 to 47 tons of this gas over every acre of the earth's surface. There is no evidence that this proportion has sensibly changed since man was created, and for all practical purposes it may be regarded as uniform from age to age. From this source, the carbon of wood is largely derived, and in the chemical operation of plant-growth, and under the action of light, it is being taken into the tissues of vegetables through the growing season—while from the respiration of animals, the vital processes of plants, combustion, decay, and other operations going on in nature, it is again given back to the atmosphere, thus maintaining its due proportions without sensible variation, as we compare observations made in different regions of the earth or at wide intervals of time.

The proportion of vapor in the atmosphere has an important influence upon vegetable growth, and every cause tending to increase or diminish the amount, will have a favorable or adverse effect upon it.

We know that water, when exposed to the open air, will under ordinary conditions, slowly evaporate, the rate chiefly depending upon the temperature, the amount of moisture already present in the air, and the movement of the lower strata of air in contact with the evaporating surface. It is known by experiment, as well as by calculation, that in a given volume, and under a uniform barometric pressure, dry air is slightly heavier than air saturated with moisture, and that it decreases a little less rapidly in weight with an increase of tem-

perature.[1] The tendency, therefore, is to bring the dry air to the surface, and so far as it operates to promote evoporation, more particularly at the warmer temperatures.

Dew Point—We may prove the presence of vapor in the atmosphere by removing the pressure, as in the receiver of an air-pump, in which, as the exhaustion goes on, the remaining air expands, and in expanding cools, until presently a cloud of vapor appears within, and the surplus moisture in the rarefied air, settles on the inside of the receiver as dew. The temperature of the air, at the moment when this dew begins to appear, is called the *dew point.* It may be more easily determined by noticing the degree of temperature at which dew begins to collect on the outside of a bright metallic vessel in which water is placed, and gradually cooled down. This process occurs in nature whenever the radiation of warmth from objects on or near the earth's surface, cools them down till the dew appears. The presence of fog or of clouds, shows that the air is there, saturated with moisture, and that the cooling point has been reached, at which the atmosphere can hold the excess of vapor in suspension no longer. No rain, snow, or dew can form, until the air is cooled down to this point, and every cause which has a cooling tendency, or that increases the amount of vapor in the atmosphere, favors, if it does not actually produce, the formation of cloud and the precipitation of the excess of moisture.

It is a well-settled principle of physics, that no matter in any form, whether solid, liquid, or gaseous, can pass from a rarer to a denser form without emitting heat, or from a denser to a rarer form without absorbing heat from all surrounding objects. Thus, when the air or vapor is expanded from any cause, it becomes cooler, and when condensed it becomes warmer. The heat absorbed when matter passes from one state to another, as from water to ice, is termed *latent heat.* This heat is given out again when the ice returns to water. The same thing occurs when water is evaporated, or is condensed from vapor to a liquid form.

Various instruments have been devised for measuring the amount of moisture in the atmosphere; the one commonly used being the *Psychrometer.* This consists of two similar thermometers, usually placed but a few inches apart, so as to be exposed to the same conditions, excepting that one of them has its bulb covered with muslin, which is wet a few minutes before observation. The evaporation from this covered bulb soon reduces the temperature to a fixed point, and a reading of both scales at that time will afford, by the aid of tables that have been prepared for the purpose, the two important facts concerning the atmosphere with reference to its humidity, upon which many conditions of climate and vegetation depend,—the absolute, and the relative, humidity.

The *Absolute Humidity*, is shown by the elastic force of vapor at a given time, in maintaining a column of mercury. This elastic force or tension, at temperatures above the boiling point, affords our steam-power, and at high degrees of heat it acquires destructive force. It exists at all degrees of heat, down to the lowest, and at temperatures commonly observed in the open air, it varies according to the differences of reading between the wet and dry bulbs of the psychrometer, as is shown in the following table:

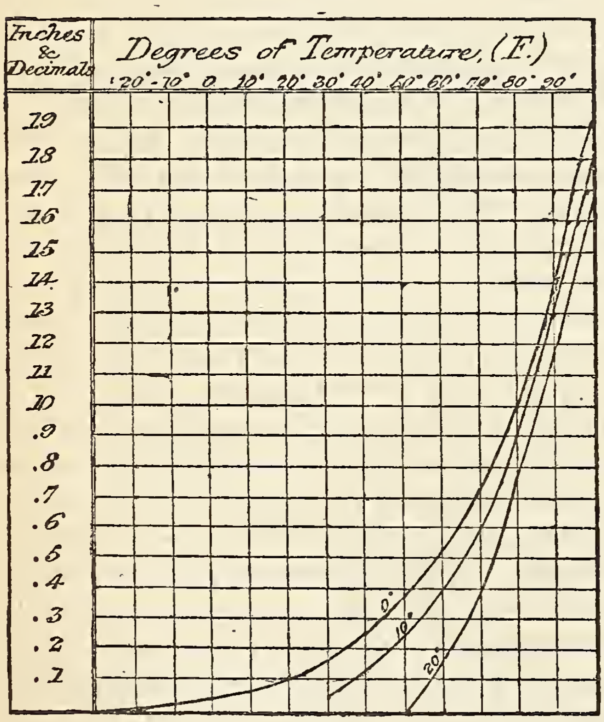
---

[1] At zero of Fahrenheit, the difference in weight in a cubic foot is but 0.44 grain troy; at 50° it is 2.44 grains, and at 90° it is 8.04 grains.

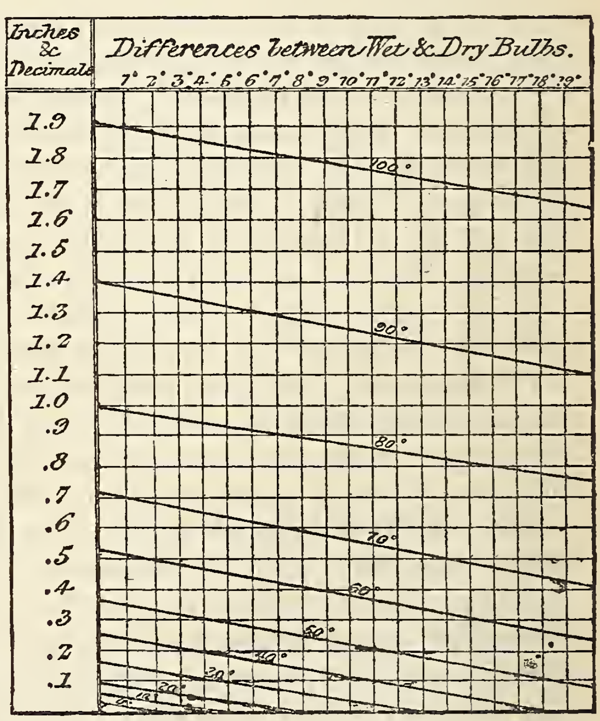
Absolute Humidity or elastic force of vapor, expressed in English inches, of mercurial column at each tenth degree, from —30° to 100° Fahrenheit, the differences between Thermometers being as shown by the left-hand column.

Difference of temp.	−30°	−20°	−10°	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°
0	.012	.018	.028	.044	.068	.108	.167	.248	.361	.518	.733	1.023	1.410	1.918
1	.001	.007	.017	.032	.057	.096	.155	.235	.348	.505	.720	1.010	1.396	1.904
2	......	.001	.005	.020	.045	.084	.143	.222	.334	.491	.706	.996	1.382	1.890
3	......	......	......	.009	.033	.073	.131	.209	.321	.478	.693	.983	1.368	1.876
4	......	......	......	......	.022	.061	.120	.196	.308	.464	.680	.969	1.355	1.863
5	......	......	......	......	.010	.049	.108	.182	.295	.451	.666	.955	1.341	1.849
6	......	......	......	......	......	.038	.096	.169	.282	.438	.652	.942	1.327	1.835
7	......	......	......	......	......	.026	.084	.156	.268	.425	.639	.928	1.314	1.821
8	......	......	......	......	......	.014	.072	.143	.255	411	.626	.915	1.300	1.807
9	......	......	......	......	......	.003	.061	.130	.242	.398	.612	.901	1.286	1.723
10	......	......	......	......	......	......	.049	.117	.229	.385	.599	.887	1.273	1.779
11	......	......	......	......	......	......	.037	.104	.216	.371	.585	.874	1.259	1.766
12	......	......	......	......	......	......	.025	.091	.202	.358	.572	.860	1.245	1.752
13	......	......	......	......	......	......	013	.078	.189	.345	.558	.847	1.231	1.738
14	......	......	......	......	......	......	.002	.065	.176	.331	.545	.833	1.217	1.724
15	......	......	......	......	......	......	......	.051	.163	.318	.531	.820	1.204	1.710
16	......	......	......	......	......	......	......	.038	.149	.305	.518	.806	1.190	1.696
17	......	......	......	......	......	......	......	.025	.136	.291	.504	.792	1.176	1.682
18	......	......	......	......	......	......	......	.012	.123	.278	.491	.779	1.163	1.669
19	......	......	......	......	......	......	......	......	.110	.264	.478	.765	1.149	1.655
20	......	......	......	......	......	......	......	......	.097	.251	.464	.752	1.135	1.641

It will be seen that these numbers increase from left to right, and from below upwards. The rate of increase horizontally, that is to say, with a constant difference between wet and dry bulb thermometers, (but ranging through all temperatures of the air from —20 to +100°), may be shown by a curve, as in the left-hand drawing, where the range for 0°, 10°, and 20° of difference is separately shown. It is seen to be a rapidly gaining rate, nearly regular, and much like a geometrical progression.



Absolute humidity at different temperatures, the difference between wet and dry bulbs being constant.



Absolute humidity at fixed temperatures, the difference between wet and dry bulbs being variable.

The formulæ do not strictly apply to high temperatures, but for the common range, the rate of increase is very regular. But if we follow any of the vertical columns downward, we observe a falling off which becomes less as the heat is greater, the common difference being from 0.011 to 0.014. If this decrease be drawn in a diagram, it will appear as in the right-hand drawing, where the columns from 0° to 100° are rep-

resented by descending lines. The left-hand marginal scales of both are alike, and show the pressure of vapor from 0.1 inch to 1.9 inches of mercury, which aqueous vapor at the different temperatures would support.

It will be seen that the intervals between the lines in the right-hand drawing widen apart from below upward in a very regular manner. These intervals would, if measured and applied to a diagram, form a curve much like those in the first drawing.

The Relative Humidity, is the percentage of saturation,—100 being complete saturation, or all that the air will hold in invisible form, and 0 being absolute dryness, a condition never obtained in our climate without artificial means. This also depends upon the temperature, and, with a given difference between wet and dry bulbs, is greatest at high temperatures. Calculated for degrees Fahrenheit, from —30° to 100°, the percentage at intervals of ten degrees, and from differences between wet and dry bulb of the psychrometer, from 0° to 20°, are as follows:

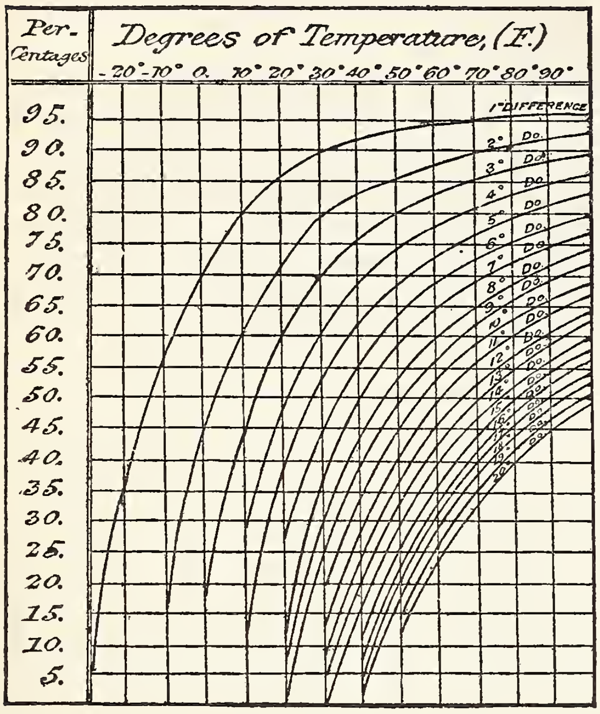
Relative Humidity, in percentages: Dryness being 0 *and saturation* 100.

Difference of temp.	—30°	—20°	—10°	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°
0	100	100	100	100	100	100	100	100	100	100	100	100	100	100
1	6	35	57	70	79	85	89	91	93	94	95	96	96	96
2	......	......	17	43	60	71	79	83	86	88	90	91	92	93
3	......	......	......	18	43	59	70	75	80	83	85	87	88	90
4	......	......	......	......	27	47	61	68	74	77	81	83	85	86
5	......	......	......	......	12	37	53	61	68	73	77	79	81	83
6	......	......	......	......	......	27	45	54	63	68	73	76	78	79
7	......	......	......	......	......	17	38	48	58	64	69	72	75	77
8	......	......	......	......	......	9	32	43	53	60	65	69	72	74
9	......	......	......	......	......	2	25	37	48	56	62	66	69	72
10	......	......	......	......	......	......	20	32	44	53	59	63	66	69
11	......	......	......	......	......	......	14	28	40	49	56	60	64	66
12	......	......	......	......	......	......	9	23	36	46	52	57	61	64
13	......	......	......	......	......	......	5	19	33	42	50	55	59	62
14	......	......	......	......	......	......	1	15	29	39	47	52	56	60
15	......	......	......	......	......	......	......	12	26	37	44	50	54	58
16	......	......	......	......	......	......	......	8	23	34	42	47	52	56
17	......	......	......	......	......	......	......	5	21	31	39	45	50	54
18	......	......	......	......	......	......	......	3	18	29	37	43	48	53
19	......	......	......	......	......	......	......	......	15	27	35	41	46	51
20	......	......	......	......	......	......	......	......	13	24	33	39	44	49

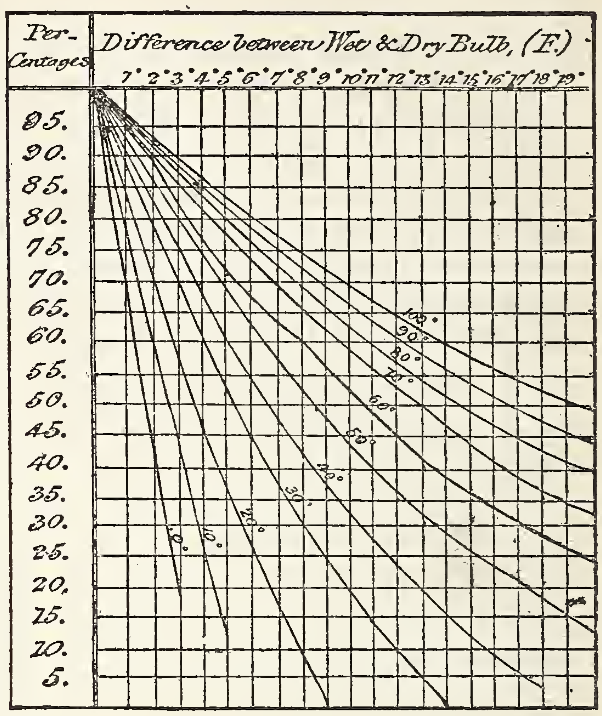
In this table, as in the preceding, the numbers increase toward the right in every line except the first, and in every column they increase upward from below. The gaining rate of the former is greatest at the beginning, and, when reduced to a diagram, the curves are convex above instead of being concave, as in the horizontal numbers in the preceding table, showing the rate at which the relative humidity diminishes with an increase of heat. But, taking at a given temperature, the difference between wet and dry bulb thermometers, from 1° to 20°, the quantities in the vertical columns diminish rapidly as we follow them down, the smaller differences at more rapid rates, but all upon the same general law.[1]

[1] Reduction-tables, based upon the formulæ of Regnault, and prepared by Professor Arnold Guyot, have been furnished by the Smithsonian Institution to meteorological observers throughout the country. The thermometers commonly used for psychrometrical observations have the centigrade scale. Other tables based upon the same formulæ, but adapted to the Fahrenheit scale and to English inches of mercurial column, prepared by the late Prof. James H. Coffin of Lafayette College, Easton, Pennsylvania, have also been issued, and from these latter, the two tables here presented have been condensed. The formulæ of Regnault are scarcely applicable to places considerably above sea-level, and new tables adapted to greater altitudes are much needed, although it may be possible to apply a correction that will render them comparable with those taken at no great elevation above sea-level.

The relative humidity is greatest at the equator, and diminishes towards the poles. It is at its maximum over the sea, and diminishes as we go inland, being lowest on the leeward side of high mountain ranges, and in places remote from the sea, as well as those most exposed to drying winds.



Relative Humidity at different temperatures, the difference between wet and dry bulb thermometers being constant.



Relative Humidity at fixed temperatures, the difference between wet and dry bulbs being variable.

With reference to the amount of rain-fall, it has been observed, as a general rule, that the quantity falling on high grounds, rising by *easy slopes*, exceeds that at the level of the sea; but if the elevation is *abrupt*, the quantity is less.

The effect of heat being to increase the capacity of the atmosphere for holding aqueous vapor in suspension, and that of cold to reduce it, or, in other words, to bring this vapor to a degree where it could no longer be held, it follows that a marked difference should exist between the temperatures at which precipitation occurs in winter and in summer, and that while the *absolute* humidity in the warmer months is very much greater, in summer the *relative* humidity is less. This may be illustrated by a few comparisons from foreign observations with others made in this country.

Absolute Moisture at several foreign stations. (Millimeters.)

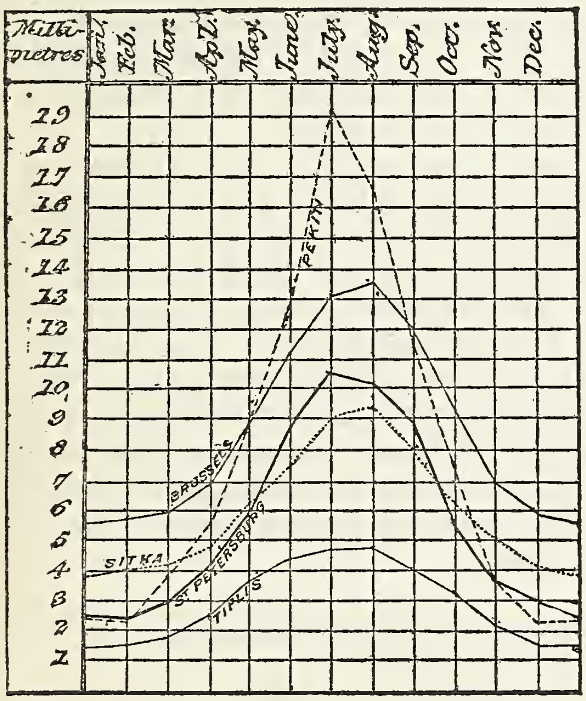
Places.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
Brussels	5.59	5.73	6.00	7.03	8.98	11.29	12.09	12.45	11.05	9.16	6.97	5.97	8.49
St. Petersburg	2.56	2.48	3.03	4.17	6.02	8.71	10.62	10.32	8.01	5.53	3.78	3.03	5.62
Pekin	2.23	2.33	3.69	5.50	8.93	13.09	19.13	16.83	11.69	6.57	3.71	2.50	8.02
Tiflis	1.45	1.59	1.82	2.46	3.59	4.24	4.67	4.65	3.96	3.14	2.30	1.72	2.97
Sitka	3.86	4.00	4.09	4.88	6.12	7.60	8.98	9.27	8.01	6.25	5.14	4.15	6.03

Relative Moisture at the above stations in the same periods.

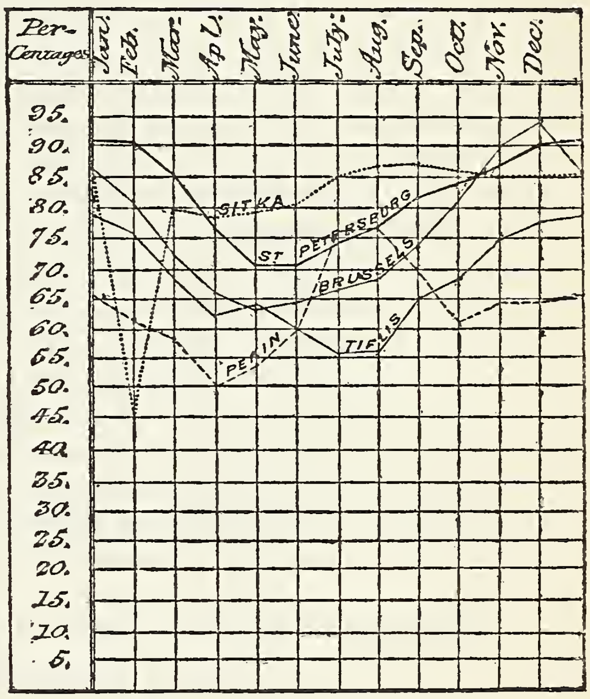
Brussels[1]	87.3	83.5	73.5	65.9	64.2	64.8	66.8	68.3	73.7	80.4	85.2	89.0	75.2
St. Petersburg[2]	90.3	89.9	85.4	77.8	71.4	71.6	73.7	77.5	82.0	84.1	87.4	90.3	81.8
Pekin[3]	65.8	62.4	58.7	50.0	53.3	60.8	76.8	77.3	70.2	61.9	64.0	64.8	63.8
Tiflis[4]	78.0	76.0	68.0	63.0	64.0	60.0	56.0	57.0	64.0	68.0	75.0	78.0	67.0
Sitka[5]	85.7	46.6	80.0	78.7	79.5	80.8	85.0	87.5	87.0	86.1	85.6	85.1	83.8

[1] From Quetelt's *Meteorologie de la Belgie*. Period, 1843–1862.
[2] Latitude, 59° 56′; longitude, 30° 16′ east; elevation, 4.5 meters. Period, 33 years.
[3] Latitude, 39° 57′; longitude, 116° 29′ east; elevation, 32 (?) meters. Period, 1850–1855.
[4] Period, December 1, 1861, to December 1, 1871.
[5] Period, 22 years while Russian territory.

These quantities are represented by graphic drawings in the accompanying figures.



Absolute Humidity through the several months of the year at various foreign stations.



Relative Humidity through the several months of the year at various foreign stations.

It will be observed that the scale of absolute humidity, on an average of several years, is remarkably regular, with its minimum in January or February, and its maximum in June or July. The rise in summer is excessive at Pekin and least at Tiflis. When reduced to a diagram, Brussels and St. Petersburg appear nearly coincident. The range for Tiflis is relatively very low, and the maximum for Sitka is carried forward into August.

The elastic form of vapor being increased by heat, we should expect to find the summer range highest in hot seasons, and that differences would be observed between years, corresponding with those of mean temperature. This, in fact, is observed on comparing records, and reducing them to graphic form in the tables.

The relative humidity is found to be influenced very much by the prevailing wind. In the Atlantic States, an easterly wind blowing several hours invariably brings an increase of humidity, more especially in winter, while northerly winds, as a general rule, cause a reduction of the percentage of moisture.

It is observed that as the sea is always of uniform height—opposing no resistance to the winds in one place more than in another, and with

no different exposure to the sun than as due to changes of the seasons—the ocean winds are much more regular than those from the land. It is this regularity that renders the winds more reliable as a motive power, in the neighborhood of the sea, than in the interior. It is to be further noticed that we find in our country no prairies or treeless plains near the sea, but always remote from its influences. The effect of resistance to an ærial current, is to condense the particles immediately in front of the opposing body, and to create a partial vacuum immediately behind it. Under these opposite influences the temperatures are correspondingly affected, and with them the hygrometrical conditions, so that high mountain peaks are sometimes capped with clouds, when the sky is otherwise clear, and these clouds clinging to the peaks, although a strong wind may be blowing.

The curve of relative humidity is considerably less at Brussels than at St. Petersburg, with its maximum in January and its minimum in May. That of Sitka, which is much higher than the rest, is lowest in April and May and highest in August and September. The other stations differ, as will be more apparent on careful study.[1]

Observations upon humidity have been made without interruption or change of plan, and with unquestionable care, at the Toronto Magnetic and Meteorological Observatory, since 1854. We have an eight-year series in Maine, at the State College of Agriculture and the Mechanic Arts at Orono, and one of fourteen years at the Michigan State Agricultural College at Lansing. Although one of these stations is across the border, it may be taken to represent the hygrometrical conditions that exist in that region, which are probably not much, if any, different from those across the lake; and a comparison of these results will serve to show the general laws which govern in the monthly average, and through a term of years, the variations in relative humidity and pressure of vapor throughout the several seasons of the year.

Hygrometrical observations at Toronto by months since 1854.

(*a.*)—MEAN ABSOLUTE HUMIDITY.

Periods.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
1854–'58	.109	.101	.126	.190	.260	.418	.514	.457	.393	.253	.174	.124	.260
1859–'63	.116	.115	.138	.181	.284	.373	.475	.487	.369	.268	.184	.127	.260
1864–'68	.095	.110	.135	.189	.271	.409	.498	.456	.380	.250	.182	.115	.257
1869–'73	.110	.104	.132	.182	.276	.417	.485	.488	.394	.250	.150	.140	.258
1874–'76	.114	.098	.118	.152	.262	.415	.483	.472	.378	.236	.170	.117	.251
Mean	.109	.106	.130	.179	.271	.406	.491	.472	.383	.251	.172	.125	.257

(*b.*)—MEAN RELATIVE HUMIDITY. (Saturation=1.00.)

Periods.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
1854–'58	.82	.81	.77	.74	.71	.75	.73	.73	.77	.76	.78	.80	.77
1859–'63	.83	.82	.77	.70	.69	.69	.73	.75	.77	.78	.79	.83	.77
1864–'68	.82	.82	.78	.71	.71	.72	.68	.71	.76	.76	.78	.80	.75
1869–'73	.82	.79	.78	.69	.67	.72	.71	.73	.77	.77	.79	.82	.76
1874–'76	.84	.83	.78	.69	.66	.71	.71	.70	.75	.78	.77	.83	.75
Mean	.83	.83	.78	.71	.69	.72	.71	.72	.76	.77	.78	.82	.76

[1] In the southern hemisphere these curves are reversed, the maxima and minima coming like their seasons, at the opposite months, and subject to laws not of interest in the present inquiry.

Hygrometrical observations at the State Agricultural College, Lansing, Mich.

(*a.*)—MEAN ABSOLUTE HUMIDITY.

Years.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
1863	......	......	......	.240	.412	.468	.532	.591	.404	.227	.164	.151	......
1864	.105	.150	.155	.275	.470	.632	.788	.558	.475	.256	.193	.111	.347
1865	.091	.118	.182	.248	.373	.596	.535	.542	.522	.265	.193	.121	.315
1866	.104	.111	.140	.236	.261	.488	.629	.464	.407	.307	.189	.123	.288
1867	.091	.152	.134	.196	.234	.556	.547	.522	.438	.285	.192	.118	.289
1868	.090	.093	.213	.224	.336	.317	.782	.545	.373	.240	.193	.114	.293
1869	.162	.148	.124	.222	.322	.496	.590	.598	.459	.219	.159	.126	.303
1870	.125	.112	.148	.267	.441	.588	.659	.594	.490	.346	.187	.139	.341
1871	.135	.132	.194	.261	.405	.522	.579	.586	.391	.307	.160	.108	.315
1872	.107	.100	.109	.260	.380	.616	.671	.650	.498	.295	.158	.092	.326
1873	.099	.110	.142	.220	.345	.534	.575	.559	.383	.245	.148	.158	.293
1874	.135	.128	.161	.169	.323	.559	.539	.527	.422	.282	.145	.135	.294
1875	.074	.075	.136	.182	.334	.467	.535	.470	.388	.219	.155	.172	.267
Mean	.135	.132	.194	.261	.405	.522	.579	.586	.391	.307	.160	.108	.315

(*b.*)—MEAN RELATIVE HUMIDITY. (Saturation=100.)

Years.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
1863	......	......	......	65.1	74.7	75.6	76.2	81.5	82.0	74.3	77.5	84.6	......
1864	66.0	70.0	77.0	84.0	77.0	81.0	80.0	72.0	81.0	80.0	77.0	73.0	76.5
1865	71.7	75.1	73.8	73.7	76.1	82.0	85.4	85.1	88.5	83.0	81.0	80.0	79.6
1866	82.0	81.0	83.0	64.0	59.0	74.0	74.0	81.0	85.0	82.0	81.0	79.0	77.1
1867	87.0	85.0	88.0	75.0	62.0	73.0	70.0	74.0	77.0	77.0	72.0	76.0	76.3
1868	80.0	83.0	87.0	75.0	66.0	76.0	77.0	73.0	80.0	73.0	84.0	90.0	78.7
1869	96.0	95.0	82.0	67.0	70.0	80.0	76.0	75.0	83.0	86.0	86.0	82.0	81.5
1870	85.0	84.0	84.0	76.0	73.0	77.0	79.0	81.0	83.0	85.0	80.0	94.0	82.1
1871	93.0	90.0	83.0	74.0	72.0	74.0	77.0	78.0	78.0	72.0	86.0	86.0	80.4
1872	88.0	84.0	85.0	74.0	77.0	78.0	77.0	83.0	85.0	84.0	89.0	91.0	79.6
1873	95.0	95.0	86.0	76.0	72.0	72.0	75.0	79.0	80.0	80.0	89.0	89.0	82.3
1874	88.0	89.0	83.0	75.0	62.0	75.0	71.0	74.0	76.0	78.0	77.0	85.0	78.6
1875	88.0	94.0	87.0	69.0	67.0	65.0	78.0	77.0	76.0	76.0	84.0	90.0	79.2
Mean	77.2	77.9	76.3	67.2	64.4	69.9	70.7	71.9	75.1	73.7	75.9	77.9	72.6

Hygrometrical observations made at the State College of Agriculture and the Mechanic Arts at Orono, Me., 1869–1876.

(*a.*)—MEAN ABSOLUTE HUMIDITY.

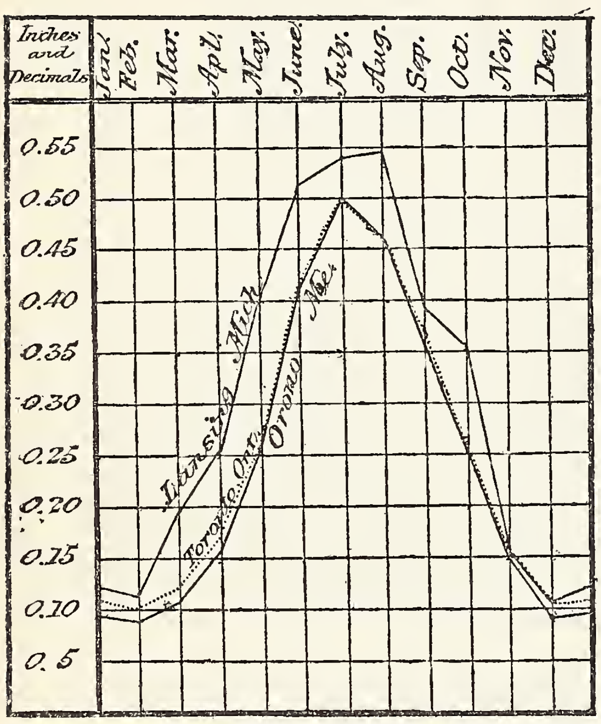
Years.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
1869	.092	.094	.099	.179	.279	.405	.495	.406	.415	.269	.162	.109	.250
1870	.108	.093	.104	.206	.264	.479	.499	.470	.363	.271	.173	.114	.279
1871	.084	.092	.159	.187	.240	.396	.482	.471	.326	.272	.132	.090	.244
1872	.087	.082	.086	.162	.280	.459	.517	.530	.403	.254	.163	.077	.258
1873	.086	.079	.118	.164	.254	.356	.497	.420	.346	.264	.109	.099	.232
1874	.112	.086	.112	.133	.255	.391	.515	.447	.402	.254	.158	.093	.246
1875	.056	.082	.101	.141	.257	.407	.490	.557	.323	.229	.129	.091	.239
1876	.099	.086	.123	.160	.256	.494	.545	.501	.342	.215	.174	.073	.256
Mean	.090	.087	.113	.169	.261	.423	.505	.475	.366	.253	.150	.093	.250

(*b.*)—MEAN RELATIVE HUMIDITY. (Saturation=100.)

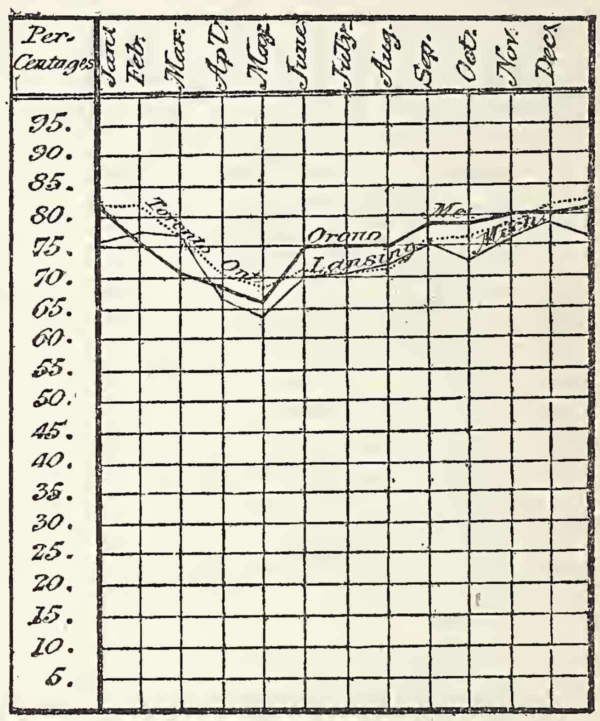
Years.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
1869	78	74	67	73	73	80	76	72	80	82	85	77	76
1870	80	80	65	73	68	76	71	72	70	79	77	80	74
1871	80	72	76	73	63	72	75	74	76	76	78	84	75
1872	82	76	76	66	73	77	74	79	81	80	83	78	77
1873	83	76	76	68	62	68	71	72	76	78	75	80	74
1874	86	77	67	67	64	74	80	77	83	75	80	81	76
1875	79	79	71	64	67	74	75	81	78	78	81	80	76
1876	81	74	74	67	69	80	78	73	79	74	79	82	76
Mean	81	76	71	69	67	75	75	75	78	78	80	80	75

The lowest means observed were,—in 1869, 26; in 1870, 13; in 1871, 17; in 1872, 23; in 1873, 20; in 1874, 19; in 1875, 24, and in 1876, 21.

These records are introduced for the purpose of showing the general effects of temperature and the seasons upon the amount of absolute and relative moisture in the atmosphere. It will be observed that at the three stations presented, there is a general resemblance, the differences being perhaps in some degree due to local causes. When represented in a diagram the absolute moisture to be greater and the maximum later at Lansing than at either of the other two stations, at which the amount and range, very nearly coincide, the relative humidity, at all the stations, reaches its minimum in May, is nearly uniform in the summer months, and is greatest in December and January.



Absolute Humidity through the several months of the year at three American stations.



Relative Humidity through the several months of the year at three American stations.

COMPARATIVE METEOROLOGICAL OBSERVATIONS IN THE FORESTS AND IN THE OPEN FIELDS.

Bavaria.

In 1868 the Royal Ministry of Finances in Bavaria directed the establishment of several meteorological stations, at each of which two series of observations were to be made: one in the open fields, exposed to all the influences of sun and winds, and the other within the shelter of the woods. Care was taken that the conditions of exposure should be as nearly alike as possible, so that the influences of the forests might be fully known. The observations in the open fields embraced records of temperature in the sun and in the shade, with common and self-registering thermometers; the absolute and relative moisture of the air; ozone; the temperature of the soil at the surface and at depths of ½, 1, 2, 3, and 4 feet; depth of rain and snow; evaporation from a free water-surface, and from soil saturated by capillary attraction, and the percolation of water through soils 1, 2, and 4 feet deep. In the woods, besides these, the temperature and ozone of the air at the tree-tops, the temperature of trees, and the effect of litter of leaves, &c., upon the soil were made

a subject of careful study, and the effect of direct sunlight was of course omitted. Records were also made upon the barometer, direction and force of winds, cloudiness, movement of clouds, and notices of rain, snow, and its lodgment in branches, fog, dew, hoar-frost, ice, &c.

The following are the instructions upon placing and observing the instruments which would be of service in the establishment of similar stations, and would tend to secure comparability of result:

Of the conditions of the place where observations should be made.—These should be made in a large forest, and in an open tract adjoining. They should be gradually extended to different kinds of deciduous and evergreen forests, and to dense woods with the ground covered and uncovered with litter, with the trees so close together as to wholly shade the ground, and to places where the light comes in between the branches. They should also include dwarf-woods, where the ground is bare and hard from the continued removal of litter—woods in which a bed of moss has formed over the surface, and in different aspects and soils.

The unwooded place for the accompanying observations should be entirely free from hills or other eminences, and of sufficient size to be free from the influence of a neighboring woodland, either by shading, cooling, or obstructing the winds. Yet the two places should not be far distant from each other, and in surface and soil as nearly alike as possible. A description should be made as regards elevation above sea-level, condition of soil, aspect, slope, and surroundings. For protection against accident or interference, the places of observation should be fenced in.

Of the putting up and management of instruments and the making of observations.—The instruments should be put up by experts, duly appointed. They must be handled carefully, and so as to prevent injury. The places of observation are never to be changed without the written consent of the director of forest stations. Should an instrument be injured, written notice is immediately given to the director, who will replace it. The following rules for observation are to be followed:

1. THE SELF-REGISTERING THERMOMETER (thermometrograph), in thinly-wooded forests and in open fields, must be protected from the direct or reflected rays of the sun by a wooden screen, and a small roof of wood, covered with zinc, should be placed over it to keep off the rain. It should be fixed upon a post, five feet above the ground, and should be perfectly horizontal. After each reading it is adjusted by holding it slanting, and by gently jarring, till the indicator, by its own weight, falls back upon the mercurial column, and the little glass bar touches the end of the spirit-column. The minus sign (—) should be placed before figures read below zero.

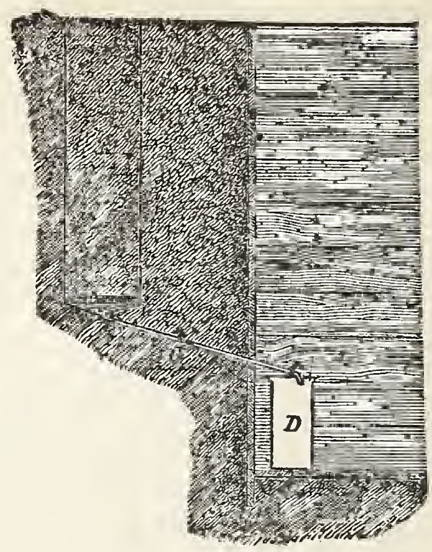
2. THE PSYCHROMETER consists of two thermometers by Lamont, and graduated to degrees and tenths (R). The pressure of vapor, in Paris lines, is determined by the readings of wet and dry bulb instruments, and by the aid of tables. Only the *difference* between them need be entered. The covered bulb is moistened by dipping in a cup of rain or snow water about a minute before reading. Care should be taken that no drop of water remains on. In winter, when this bulb is covered with ice, wetting is unnecessary. In summer, repeated dippings are often required, as the water does not adhere freely. If the dry bulb has become wet, or is covered with frost, it must be carefully wiped dry about ten minutes before observation, which should never be made until it has returned to the temperature of the air. In reading, the eye of the observer should be level with the point read, taking care not to affect the instrument by bringing the face too near or by breath or touch. This instrument is put up on the same frame with the self-registering thermometer, and under the same roof.

3. RAIN AND SNOW GAUGES.—The rain-gauge, by differences of record, should show the amount of water intercepted by the leaves and branches. In the woods, the instrument should be in a place where the trees are so close that their branches interlace, as they average, and in the open fields, so that no rain may be driven in from roofs or other objects. The receiving-surface has an area of one square foot. It should be level, and about 8 feet above the ground. Snow, hail, and sleet, are to be measured in a melted state, and a spare receiver of equal size is used while the other is removed for melting the contents. In case of heavy falls of snow, the contents may be pressed down, and when full another should be placed. The water is drawn off into a glass cylinder graduated into Paris cubic inches and lines, and measured. Its actual amount must be recorded, and not the height at which it stood in the cylinder. After each reading the glass cylinder should be carefully wiped with a linen cloth. The metallic vessels are also to be kept clean. To avoid too low estimates, extra measurements should be made in cases of heavy falls of rain or snow.

To find the amount of water lost by evaporation, running off, or soaking into the ground and draining away, in fields and woodlands, zinc vessels, 1 Paris foot square at the top and 1, 2, 3, and 4 feet deep, are provided, with a double bottom, the upper one of which is perforated, and fastened about four inches above the lower one, as shown at

A, in the accompanying figure. This vessel is filled with earth taken from near the place where the observations are to be made. The depth from the surface to the false bottom is that at which the observation is proposed to be made. The lower bottom is funnel-shaped, and is connected with a leaden pipe, through which the water flows into a receiving vessel (D.), for measuring, from time to time. To accomplish this, a pit is dug, 10 feet long, 6 feet wide, and 5 feet deep, and into this the discharge-pipes from the instruments, at several depths, are brought. Such an instrument is called a *Lysimeter*. If the surfaces of some of these are covered with moss, leaves, humus, turf, &c., while others are left with bare earth, the influence of these coverings upon the percolation of water may be determined. This instrument should at first have the surface of the earth within it a little higher than the ground, so as to allow settling, and it should be left some months undisturbed before beginning observations, so as to allow the contents to get compacted, as occurs naturally in the soil. From this we get data for learning the amount of water that penetrates the soil and reaches springs. If we deduct the amount collected from the rain-fall, we get the amount evaporated, lost, or absorbed by vegetation.

Lysimeter.



4. THE EVAPORATION METER (atmometer) determines the daily and yearly amount of water returned to the air by evaporation. Comparisons of the amount of evaporation and of rain-fall will show, in certain localities, that more water is evaporated than falls in rain, &c. The instruments should be freely exposed to the winds, but should be sheltered from rains, snows, and the direct rays of the sun. Lamont's atmometer, shown in the annexed engraving, consists of three principal parts, a water-reservoir, *a*, *b*, *c*, *d*, an evaporating-bowl, *f*, *g*, *h*, and a connecting tube, *R R*. A piston, passing through an air-tight packing, is so arranged that it may be pressed down into the reservoir or raised by the screw *S*, and an index, *n*, attached to this, points to the degrees on a graduated scale, *s s*. This scale may be raised or lowered, so that its zero point is opposite the index point *n*, when the instrument is set at the beginning of an observation. The mode of operation and of reading are as follows: The piston is drawn up, and rain-water is poured in at the bowl till it stands at the point *A*. The reservoir being full of water, the scale is set so that the index points to zero, and the piston is then pressed down, so that the water in the bowl is forced up so as to stand level with a line *M. N.* marked on the inner side just below the rim. When an observation is made, some time after, the piston is raised and all the water in the bowl is drawn in until it stands just level with the opening *A*. If there had been no loss, the index would then point at zero; but, as more or less evaporation has taken place, the difference is at once shown by the index on the scale. More water is added, if necessary, the scale is again set, and the water pressed up to the mark near the rim of the bowl, as before, and left till next observation. The bowl having a much greater sectional area than the reservoir, the graduation of the scale is enlarged in corresponding degree, as compared with the depth actually evaporated if measured in the bowl itself. The scales used were graduated to tenths of Paris lines, and the reading by estimation could be had for smaller distances.

Lamont's Atmometer.

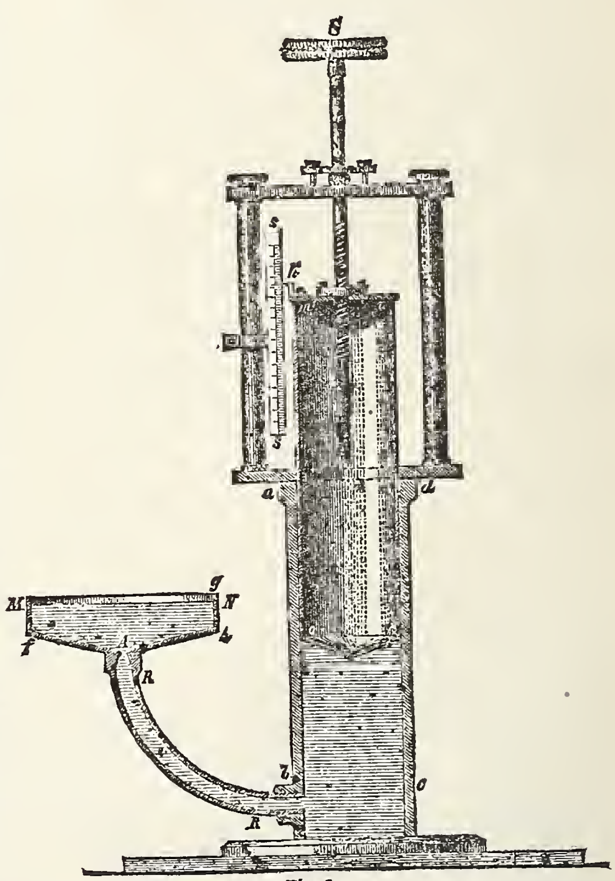


Fig. 2.

The instrument is placed upon a stand about 5½ feet above the ground, freely exposed

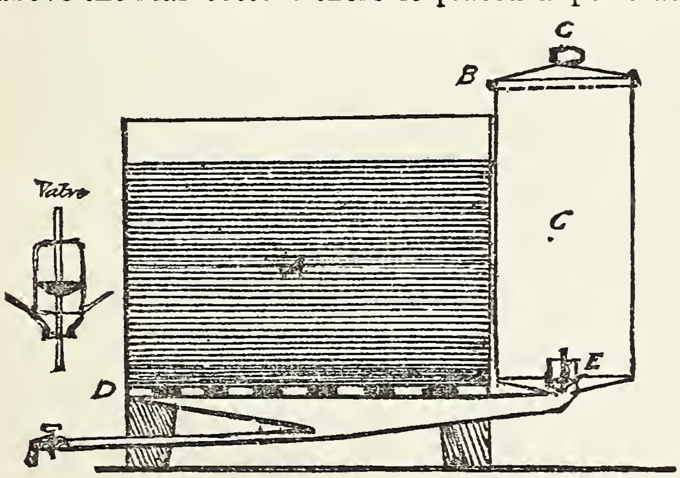
to the air, but sheltered from the sun and from rains, and is adjusted to a level. The evaporating bowl has an area of one Paris square foot, and is about three inches deep. Observations cannot be made when the temperature is below the freezing point. Full details of the arrangement and use of this instrument were first given in the weekly report of the Munich Observatory, No. 158, 1868.

[Before this instrument was introduced, a simpler form of apparatus was used for determining the amount of evaporation. It consisted of a broad shallow zinc vessel, of known area, deepest in the middle, where it was connected with a discharge-pipe, closed by a cock. Being filled by a measured quantity of water, it was exposed to the open air, and the water drawn off and measured, from time to time, gave the amount of evaporation. A still simpler form was a shallow pan, of known area, filled with water and weighed from time to time, or supported by a spiral spring, which gradually arose, carrying an index, as the weight became less.]

These instruments, in whatever form, give very different results, according to the material of which the pan is made. If of metal, it may become warm in greater or less degree, according to the conducting power of the metal used. This result, however, becomes less important, where all the instruments used in the comparative observations are alike in area, material, and exposure.

Evaporation from soils.—The instrument for showing the amount of evaporation from the surface of soils entirely bare, or covered with wood-litter, moss, or leaves, &c., was constructed as follows:

A box, A, is made of zinc, one Paris foot square, and 8 inches deep. At 2 inches above the real bottom there is placed a perforated plate. An open cylindrical zinc vessel, B C, is connected with the box by a tube. Into this there is slid another vessel, C, a little smaller, which is closed at the top, and is furnished with a valve at the bottom, opening upward and attached to a spindle, as shown by the enlarged figure. When in position, this valve should stand level with the perforated bottom of the box. A thin mat of straw is first laid over the perforated bottom, and the box is then filled with the same kind of soil as that which is found at the station, either left with the surface bare or covered with moss, leaves, or other substances, according as it is desired to measure their effect upon evaporation. When the instrument is used the closed vessel, C, is withdrawn, turned bottom upward, and filled through the opening at the valve; then, drawing the valve up with the fingers to close it, the vessel is turned into proper position and placed in the open cylinder. The valve rises as soon as the vessel full of water touches the bottom of the outer shell, and the water flows in and fills the vacant space below and up to the perforated plate. At this point the valve closes by the pressure of the water, and the further access of air is stopped. The water will rise through the soil from the perforated plate by capillary attraction and evaporate from the surface, more being admitted by the automatic action of the valve as the water below the soil gets below its level, a little air at the same time getting into the closed reservoir; and it will thus continue to operate, the soil being always uniformly damp as long as any water is left in the reservoir.



Instrument for measuring the evaporation from soils.

5. The earth thermometer.—For purposes of forestry, it is sufficient to determine the temperatures at the depths to which roots penetrate and spread their roots, and for this purpose observations are made at depths of ½, 1, 2, 3, and 4 feet by thermometers sunk to those depths,[1] and arranged so that they may be easily withdrawn for observation.

Earth Thermometer.

[1] In some cases thermometers, with stems several feet long, have been placed in the earth, which allowed of readings without withdrawing them from the soil. The instruments used at the Bavarian stations are the same as described by Dr. V. Lamont, in No. 19 of the Weekly Report of the Royal Observatory (Munich), and in the fourth supplementary volume of the Annals of the Munich Observatory, p. 91, plate iv. They differ from common thermometers by having the mercury in the bulb surrounded by thick glass, which, being a slow conductor of heat, will not allow sensible changes to occur when the thermometers are drawn up for observation.

6. Winds.—Where the situation permits, the wind-vane should be fixed on a dwelling, and should be fastened to a spindle which reaches the ceiling of a room on the first floor, with an index corresponding with the indications of the vane on a dial marked with the eight principal points. In classifying the different degrees of force, 0 signifies calm; 1, a slight wind, gently moving the leaves; 2, a moderate wind, which moves the branches of the trees in the open field and creates a slight noise; 3, a strong wind, moving the larger limbs of trees, walking against it being difficult, and light objects being carried by it into the air; and 4, a storm, keeping the trees in constant motion, and occasionally breaking branches and carrying leaves and dust to a great height, accompanied by a loud whistling noise and incessant gusts of wind. Walking against this wind is difficult and almost impossible.

7. Cloudiness.—The extent of cloudiness is divided into four degrees: 0 denotes a clear sky, and 4 denotes entire cloudiness, and is also used for a thick fog or a rain that covers the whole horizon. The numbers 1, 2, 3 denote intermediate degrees.

8. Movement of clouds.—The direction of movement in clouds should be noted where possible, and, if at different heights, their several directions. No entries are to be made where the motion cannot be ascertained.

9. Precipitation.—In recording watery deposit, R is used for rain; S, for snow; R S, for rain and snow; H, for hail; Sl, for sleet; D, for dew; F, for frost; and Fg, for fog. The latter may be *rising, falling, heavy* or *thick, moderate* or *slight,* and should be marked by these words. The time of occurrence and the duration of these several forms of precipitation are to be indicated by adding two figures denoting their beginning and ending, as R, 2–6 p. m.

Hours for observation.—Daily observations should be made at 9 a. m. and 5 p. m. from March to November, inclusive, and at 9 a. m. and 4 p. m. in December, January, and February. In expectation of prompt attention to their duties on the part of observers, the number of daily observations has been fixed at two only. At 9 a. m. the minimum temperature of the night, and at 5 p. m. the maximum of the day should be read on the thermometrograph and entered, always readjusting the instrument. One daily observation of the rain, at 5 p. m., is sufficient, unless unusually heavy rains should make more than one measurement necessary.

The instruments in the open fields should be read first, and those in the woods immediately after. First note the temperature of the air on the dry thermometer of the psychrometer; next wet the other bulb; then read the maximum and minimum thermometer; then the atmometer, rain-gauge, and earth thermometers; and lastly, read the wet bulb thermometer. After this, note the winds, cloudiness, and any remarks that may be necessary. On the last day of each month the water is drawn off from the sunken vessel and measured. Days on which, at any of the designated hours of observation, the temperature is below the freezing point, or frost has occurred during the night, are to be noted as "frost days," or if snow has fallen, "snow days." If, from any cause, the observer is prevented from making the observations himself, he must employ a competent and reliable person to supply his place. When this is not practicable, the columns under their respective heads must be left blank. If, however, within an hour or two afterward, he should be enabled to make the observation himself, he must do so, noting the time under the head of "remarks." *Under no circumstances* should the observer enter anything in the tables obtained from his own calculations on guess-work. It is recommended to observers that they *never* rely upon memory, but that they make the entries in pencil in a memorandum-book at each reading, and *immediately* after reading, the same to be copied into the blanks as soon as he reaches home.

Transmission of the tables.—On the first day of each month the tables are to be transmitted to the director of the Central Forest Academy. Each observer will receive two blanks for each month, one of which he may retain for his own use. In all cases the original is to be sent—never the copy.

Under this system of observation seven stations were established, viz: At *Duschlberg* (2,776 Paris feet above sea-level); at *Seeshaupt* (1,830 feet); at *Rohrbrunn* (1,467 feet); at *Johanneskreuz* (1,467 feet); at *Ebrach* (1,172 feet); at *Altenfurth* (1,400 feet); and *Aschaffenburg* (400 feet). For a part of the time observations were included from *Promenhof.* The temperatures given are those of Reaumur's scale, in which freezing water is 0°, and boiling water 80°.

At the end of four years a synopsis of results was published by Dr. Ernst Ebermayer,[1] from which the following summary is derived. They are ac-

[1] *Die physikalischen Einwirkungen des Waldes auf Luft und Boden, und seine klimatologische und hygienesche Bedeutung.* Berlin (1873), pp. xii, 266, and 253, with an atlas.

Dr. Ebermayer has also published another volume of forest results of observations

companied by observations upon vegetable physiology and other subjects closely related to climatic influences.

Temperature of the air in the open fields and in woodlands.

The climate of a given country or locality depends, in the first place, on the temperature of the air; and if we wish to learn the influence which forests or clearings have upon the climatic conditions of any place, comparative observations must be made in wooded and in cleared places through a considerable time. The warmth of the air is communicated from the sun, either by direct absorption of the solar rays, by reflection from the warmed surface, or by radiation from the surface that has been warmed. Most of the warmth of the air is from the latter. The air coming in contact with the warmed surface, expands and rises, to be immediately replaced by cool air. The air in the forest is cooler, because the sun's rays do not reach the soil directly. The atmosphere is there warmed more from the earth than by the direct rays of the sun.

The annual mean temperature of the air in the woods is somewhat lower than in an unwooded space, but the influence is very small in the yearly result. The annual mean temperature of the air in the forest increases steadily from the surface of the earth to the tree-tops.

But the annual mean temperature of a given locality affords but a very uncertain knowledge of the climatic character of the place. A hot summer and a cold winter may have the same annual mean as a cold summer and a mild winter. The distribution of the warmth of the air among the seasons, especially in the spring and summer, is of more importance to plant-life than the yearly warmth.

In the spring the forest air, at the height of five feet, is generally cooler than the air in the open fields.

In summer (the principal season of growth), the *differences* of temperature between the air of the forests and fields have been greater, at all places of observation, showing the influence of woodlands, as well upon the temperature of the air as upon the soil. The hotter the summer the greater the effect upon both. The absolute influence of the woodlands upon the soil is twice that which they have upon the air, as on the average, the air in the forest during the day was 1°.68 (R.) colder than in the open field, while in the mean temperature of the forest soil was 3°.24 (R.) lower than in the open fields. These results show that in well-wooded countries, in summer, the daily mean of the air, but more so of the soil, must be lower than in thinly-wooded regions. The clearing of lands will, therefore, raise the temperature of both air and soil, and cause increased evaporation and greater dryness.

In autumn, the influence of forests decreases, both in the air and the soil, and the difference of air-temperature in the day-time, in the general average, is only 0.° 45 (R) less than in the open fields.

In winter, the difference is very small, the air in forests being slightly colder than in the fields. This is at variance with the prevailing opinion, that the woods are warmer in winter than the open country, and

---

at stations, the work being entitled, *Die gesammte Lehre der Waldstreu, mit Rücksicht auf die chemische Statik des Waldbaues.* Berlin (1868), pp. xii, 300, and 116.

No results of forest meteorological observations have been published by this author since 1873, but as ten years of record will have been completed on the 1st of March, 1878, he then proposes to give the results of this period, using the accumulated materials in a fuller study of the climatic conditions of woodlands. Dr. E. informs us in correspondence, that he is now engaged in the preparation of a work on the chemistry and physiology of plants in their relation to sylvaculture and agriculture. A ten-year series of phaenological observations (periodical phenomena of animal and vegetable life) will also be completed in 1878, and the results will then be published.

that densely-wooded regions are warmer than where the growth is thin.[1] In mild winter days, with a warm southwest wind, the forest is colder than the clearings in the day-time.

Comparison of the air-temperature and soil-temperature at different seasons.

In the clearings, the mean temperature of the air in summer and winter were almost the same as the temperature of the surface of the soil. Comparatively small variations occurred in the spring and fall, when in the total average the surface of the soil was 0.° 03 (R) colder (in spring)—or 0.° 37 warmer (in autumn) than the air.

Amount of moisture contained in the air in the forest and the open field, or influence of the forest on the amount of water contained in the air.

The climate of any place is determined by the temperature and moisture of the air. Watery vapor forms one of the most important constituents of the atmosphere. It is often observed condensed in visible form in small vesicles as fog or cloud, and it is always present in greater or less amount as invisible gas, even in a perfectly clear sky. As this atmospheric vapor in several respects is of great importance, the determination of its amount at different times and places is one of the most important tasks in meteorological researches. Without vapor there would be no clouds, no rain, fog, dew, snow, frost, or hail, no lightning or thunder, no rainbow, no blue sky, no rosy twilight. We will state here only what is most essential regarding the importance of moisture in the air.

Damp air deadens the extremes of heat and cold. Where the air is dry, we are exposed to the most extreme temperatures by day and night. On the plains in India, on the top of the Himalayas, in Central Asia, in Australia, in fact everywhere where the air is dry, we find great heat during the day, forming a dangerous contrast with the cold night following. In the dry air of the Desert of Sahara the change is so great as to sometimes carry the temperature to freezing, or even to the formation of ice. These known phenomena are in definite relation with the small amount of moisture contained in the air of those regions.[2]

The more vapor there is in the air, the easier it is for a part of it to condense in the form of rain, snow, fog, or dew.

Aside from the climatological importance of moisture in the air, it is not immaterial to plants whether the air is moist or dry, because dryness increases the transpiration of water from the leaves, buds, stems, &c., while moisture in the air retards this process, in degree corresponding with its amount.

In a moist atmosphere the soil is fresher and more productive than in an arid one, because the evaporation of water in the soil takes place more slowly, and it holds more from watery precipitation than the dry air.

---

[1] A reason for the apparently greater warmth of the woodlands than the open fields, as judged by our sensation, will be explained further on in speaking of the humidity of the atmosphere, and the effect of dry winds.

[2] The contrasts between the temperatures of day and night, on our western plains, has been noticed by all travelers who have crossed them, and they have been often described by writers; yet from the dryness of the atmosphere, the transpiration from the surface is more rapid, and this itself is a cooling process, so that a person would scarcely *feel* a temperature of 110° more than one of 90° in the humid climates of the sea-coast. In these dry regions, colds are seldom taken by exposure to the night air, and in certain pulmonary diseases, a salutary effect is observed, if relief is seasonably sought.

Finally, the greater or less amount of moisture contained in the air has great influence upon human health. Dry air has very often an injurious effect upon the organs of respiration, and the fact that we breathe easier in forest air is due to the greater relative moisture. In dry air the cutaneous perspiration is increased, and more warmth is taken from the body.

After these introductory remarks, we will proceed to show the effect that forests have upon the moisture of the air. As the evaporation of water increases with the increased warmth of the air, it follows that the absolute amount of moisture in the air must be greater in summer than in winter, and must amount to more in lower and warmer regions than in those that are higher and colder. We give below the general mean average pressure of vapor for the different seasons of the year:

Comparison of average absolute moisture, or pressure of vapor, by seasons.

Seasons.	In open fields.	In woodlands.	Difference.
Winter	2.05 Paris lines	2.16 Paris lines	0.11
Spring	3.14 Paris lines	3.18 Paris lines	0.04
Autumn	3.16 Paris lines	3.25 Paris lines	0.09
Summer	5.21 Paris lines	5.20 Paris lines	—0.01

Forests do not, therefore, during the year, or in the several seasons, exercise much influence upon the *absolute* moisture of the air. But in saying this we must bear in mind the distinction between *absolute* and *relative* moisture. By the former we mean the amount of vapor contained in a given space, as for instance a cubic foot, which, although invisible, has an independent pressure upon the mercury of the barometer. It cannot be directly read upon that instrument, but is shown by observations upon the psychrometer, or wet and dry bulb thermometers, and is calculated from tables.

The weight of vapor contained in a given volume of air saturated with moisture increases with the temperature, as is shown by the following table:

Weight of vapor in a cubic foot in saturated atmosphere at different temperatures.

Degrees (F.).	Weight in Troy grains.	Degrees (F.).	Weight in Troy grains.	Degrees (F.).	Weight in Troy grains.
0	0.78	40	3.09	80	10.81
10	1.11	50	4.28	90	14.50
20	1.58	60	5.87	94	16.22
30	2.21	70	8.00		

The higher the temperature, the greater therefore is the capacity of moisture. The *relative* moisture is its percentage of saturation, dry air being 0, and air perfectly saturated 100. By increasing the heat we therefore reduce the percentage or relative amount of moisture; and, the absolute moisture being the same, the tendency to precipitation is greater in cool air, and hence more in woodlands than in the open fields.

According to Rivenot, climates having an average relative moisture below 70 per cent. are denoted *dry*, and where over this *moist*. A *very dry* climate has the percentage 55; *moderately dry*, 56 to 70; *moderately moist*, from 71 to 86, and *very moist*, from 86 to 100. An equal "absolute" amount of watery vapor may be relatively moist or dry, according to the temperature, and every cause which in any way tends to raise or lower the temperature in corresponding degree increases or lessens the relative moisture.

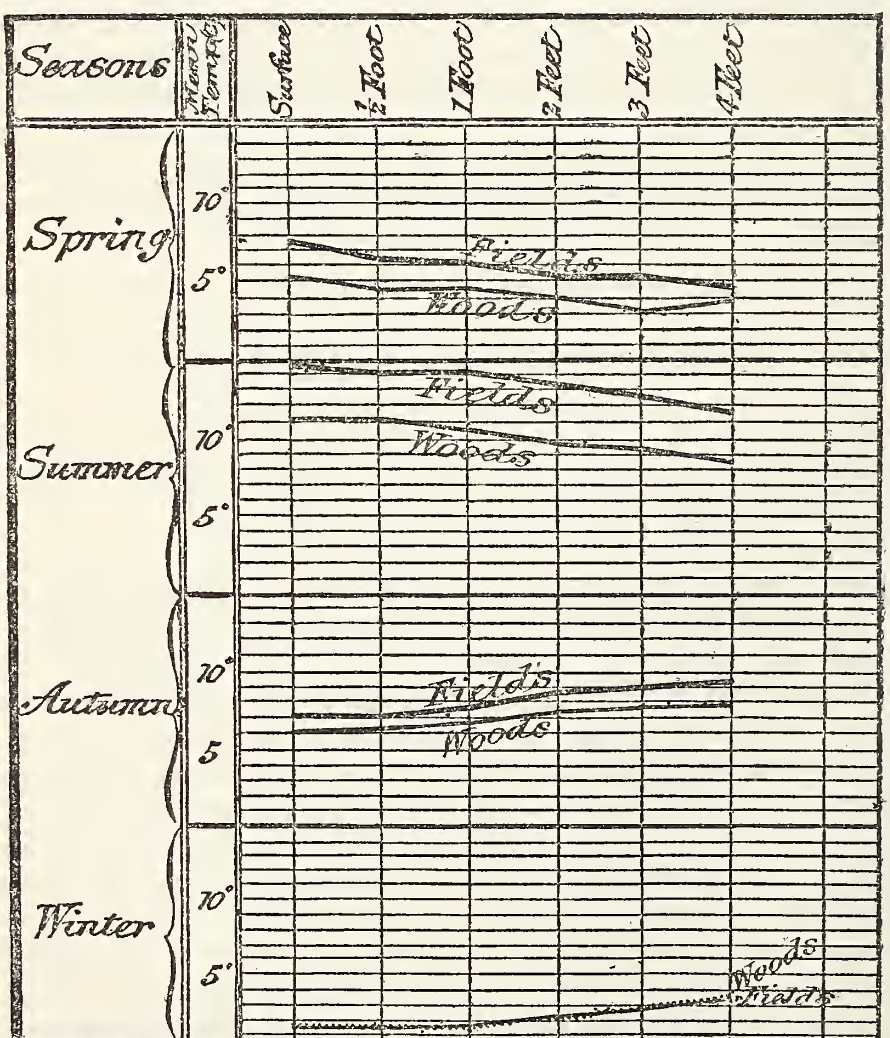
Mean temperature of wooded and unwooded soil, from the surface of the earth to the depth of four feet, or influence of the forests upon the mean annual temperature of the soil.

The tables resulting from this series of observations show that the yearly means of a given location, at the several depths observed, are nearly constant. The difference is less in the forests than in the fields, and less at greater depths than near the surface. The mean temperature diminishes with the depth, and is least at 4 feet. The general results are given the following table:

Mean temperature of the earth by seasons (Réaumur's scale).

Season and location.	At surface.	Half a foot.	1 foot.	2 feet.	3 feet.	4 feet.
Spring:						
In woods	5.26	4.63	4.40	4.00	3.66	3.58
In fields	7.29	6.35	6.02	5.60	5.03	4.77
Difference	− 2.03	− 1.72	− 1.62	− 1.60	− 1.37	− 1.19
Summer:						
In woods	11.28	11.14	10.72	9.89	9.23	8.53
In fields	15.01	14.09	14.05	13.38	12.46	11.70
Differencee	− 3.13	− 2.95	− 3.33	− 3.49	− 3.23	− 3.17
Autumn:						
In woods	6.08	6.16	6.60	7.21	7.45	7.63
In fields	7.09	7.09	7.64	8.48	8.91	9.22
Difference	− 1.01	− 0.93	− 1.04	− 1.27	− 1.46	− 1.59
Winter:						
In woods	1.35	1.24	1.71	2.39	2.85	3.30
In fields	1.56	1.20	1.57	2.31	2.89	3.44
Difference	− 0.21	0.04	0.14	0.08	− 0.04	− 0.14

The relation between these numbers may be readily shown by a diagram:



Mean temperature of the earth by seasons at different depths below the surface.

The differences at the several stations very nearly correspond when the annual results of years are taken, although circumstances of soil or exposure appear to have had a local influence in some cases. But of these causes, none is more apparent than that of elevation above sea-level, the average becoming cooler as the elevation is greater.[1] The observed differences between stations are shown in the following table:

Comparison of annual and summer temperatures of stations.

Stations.	Height above sea-level, Paris. Feet.	Average temperature at 4 feet (R.).			Summer average at all depths to 4 feet (R.).			Winter average at all depths to 4 feet (R.).		
		Open fields.	Woods.	Difference.	Open fields.	Woods.	Difference.	Open fields.	Woods.	Difference.
Duschlberg	2,776	3.31	1.63	1.68	11.48	8.56	2.02	0.78	0.58	− 0.20
Seeshaupt	1,830	5.95	3.61	2.34	13.64	10.39	3.23	1.60	1.63	+ 0.03
Rohrbrunn	1,460	6.30	4.95	1.35	13.69	10.58	3.11	2.43	2.38	− 0.05
Johanneskreuz	1,467	6.66	5.16	1.50	14.32	10.04	4.28	3.33	3.30	− 0.03
Ebrach	1,172	6.04	5.02	1.02	13.93	11.11	2.82	2.38	2.27	− 0.11
Altenfurth	1,000	6.70	5.16	1.63	13.68	10.71	2.92	2.45	2.69	+ 0.24
Mean of above	....	5.84	4.25	1.59	13.44	10.23	3.21	2.16	2.14	− 0 02
Aschaffenburg	400	8.00	......	......	15.74	....	......	3.95	......	....

It appears from the above table that the laws that govern the changes of temperature in the soil are not much affected by differences of elevation.

By inspection of the preceding table of temperatures by seasons, it will be seen that while the deeper strata on the annual average are colder than the upper ones, this difference is very slight in winter and very considerable in summer. From this we may infer that the influence of latitude would be very sensibly felt, as the prevailing temperatures of hot and cold climates assimilate themselves to those of summer and winter. Hence, woodlands afford much greater protection in summer than in winter, and the differences should be more sensibly felt in warm than in cold countries. The relative warmth of soil in winter in the woods, as compared with open fields, may, perhaps, in part be ascribed to its protection against cold winds, while in snowy countries the detention of the snow in an even stratum must exert a notable influence upon the temperature of the soil by hindering the penetration of frost.

The cooler temperature of the deeper strata in spring may explain the reason why trees that send their roots down deep into the soil, such as the oak, do not put forth leaves as early as those where the roots lie nearer the surface.

The relatively colder soil of woodlands in summer has a close relation to the retention of water and the maintenance of springs in wooded regions, although hinderances to evaporation from the soil and its porous condition in woodlands may be the principal reasons for the differences observed.

On comparing the earth temperatures of spring and fall, we find at

[1] From observations made in the Siebengebirge, Bischof, of Bonn, calculated a decrease of warmth in the soil of 1° (R.) for every 683 Paris feet of elevation. From observations made in Bavarian forests, a difference of 1° (R.) was found in 746 feet, while between places of nearly the same level a disparity was noticed that could not be explained except in inequality of soil and situation.

all depths to 2 feet a greater difference between open fields and woods in the former than in the latter, it being 1°.02 R. at the surface, 0°.79 at half a foot, 0°.52 at 1 foot, 0°.33 at 2 feet, while at 3 and 4 feet the temperatures of autumn are higher than those in the spring by 0°.09 and 0°.40, respectively.

The deductions of observations are considered separately by months, with a consideration of their influence upon vegetation; but our space does not admit of these details. Their tendency will be inferred from what has already been shown in respect to the seasons.

As regards the temperature at different hours in the day, it is found that in the open fields the temperature is highest in the afternoon throughout the year. The daily variation is greatest at the surface, and it decreases with the increasing depth. At 3 feet it averages but 0°.01 or 0°02 R., and is so slight as to have but very little practical importance. These daily variations in the temperature of the soil differ considerably with the seasons, being greater in summer than in winter. They are about the same in spring as in summer, and become less in autumn. In wooded soil the difference of temperature in morning and evening at all depths and on the surface is less than in the open field. The greatest difference is observed in May. Forests, therefore, diminish the daily variations of temperature and their spreading in the soil. The daily change is less as the elevation above sea-level becomes greater, as is shown by the following table:

Differences between the temperature of soil in the woods and the open fields at different elevations.

Stations.	Alt. above sea-level.	Surface.	Half a foot.	1 foot.	2 feet.	3 feet.	4 feet.
		°	°	°	°	°	°
Seeshaupt	1,830	2.80	1.23	0.31	−0.08	0.01	0.03
Rohrbrunn	1,467	2.30	1.77	0.08	−0.03	0.01	0.03
Johanneskreuz	1,467	2.46	2.31	0.28	−0.09	0.01	0.01
Altendorf	1,000	3.10	0.96	0.33	−0.06	0.02	0.01
Aschaffenburg	400	2.56	1.91	0.05	−0.07	0.02	0.00

As to the temperature of the earth in the forest and in the open fields to the depth of four feet, or the influence of the forest on the warmth of the earth.

Experience has proved that a warm soil is more favorable to vegetation than a cold one. But to better understand the influence and importance of warmth in the earth to the development of plants, investigations and observations have been made by Sachs, and later by Bialoblocki, which led to the following results:

1. By increased warmth of the earth, the growth of plants, especially in their first stages of development, is hastened.

2. Heat operates directly on the development of the roots, and through them indirectly upon the parts of the plant above the surface, thus affecting the growth of the whole plant. The branching out and development of the root is materially increased by raising the warmth.

3. The degree of activity in the roots being dependent upon the temperature, the absorption of moisture follows in corresponding degree. If the temperature is lessened, the function of the roots is diminished, and at 41° Fahrenheit the absorption by some plants, as, for instance, the tobacco and the cabbage, is insufficient to supply the loss by evaporation from the leaves, causing them to wilt, especially if exposed to the direct rays of the sun. A rise of temperature, on the contrary, increases the absorbent power of the roots.

4. Increased warmth in the earth promotes the circulation of the sap and the evaporation of water from the leaves.

5. Another indirect action of warmth in the earth, in its influence upon vegetable life, is to hasten the process of decay of organic matter in the soil, so that plants, other circumstances being equal, will obtain more nourishment in a warm soil than in one that is cold.

6. Different plants require different temperatures for successful growth. Thus rye requires less heat than barley or wheat. But if the warmth of the earth exceeds the maximum needed for a given plant, a diminution of growth is the consequence. The highest temperature at which life can exist in a root is about 105° F.

7. Upon the awakening of vegetation in the spring, the temperature of the earth has a very important effect upon the germination of seeds. The various grains require at least 42° to 45°, and growth does not begin in most perennial plants until this degree is reached. From this it will be seen that several of the functions of vegetable life do not take place, or act but imperfectly, at a low degree of heat in the earth, and the agriculturist properly seeks the causes of failure in crops, not always in the low temperature of the air, but in that of the soil, especially if prolonged in the spring. Since we know that the warmth of the earth is of great importance in the vital process of plants, the watering of house-plants with water warmed to blood heat has been recommended. A striking instance of the action of artificial heat upon plant-life is reported by Dr. Aug. Vogel.[1] In a garden at Munich two beds of earth were artificially heated through the whole summer by means of a perforated lead pipe attached to a steam-boiler and buried four feet in the ground, so that the earth thermometer rose to from 72° to 100° F. The effect was noticed in deep rooting, but more especially in tropical plants, some of which grew to actual monstrosities. By this we are reminded of the horticultural garden near Zwickau (Saxony), where the artificial heat from burning coal-mines is made useful.[2]

Amount of evaporation from a free water surface in the woods, and in the open fields, or influence of the forests upon such evaporation.

It is important, not only in its climatological relations, as well as in a purely forestal stand-point, to ascertain from exact observations a knowledge of the amount of water evaporated in the forest and outside of their influence, because it explains to us many phenomena, and because these observations add much to the determination of the physical influence of the forest upon the air and soil.

Water evaporates at any degree of temperature. The amount evaporated on a given area is governed by the temperature, as with each degree of temperature only a certain amount of water can assume the form of vapor. The amount of evaporation, therefore, depends chiefly on the existing temperature, and on the amount of vapor already contained in the air; next, on the pressure of the air; still more on the removal of vapor, when formed, by currents of air; and lastly, on the size of the water surface exposed to evaporation.

[1] *Zeitschrift des landwirthschaftlichen Vereines*, 1872.

[2] In this connection we should not forget to mention that observations upon the temperature of the soil have of late become of more general interest from a supposed connection with the origin of cholera. In the *Zeitschrift für Biologie* (vol. iv, 1868), Dr. Delbruck remarks that not only the moisture of the earth and movement of subterranean waters, but also the temperature of the earth, are causes for originating and spreading this epidemic disease, by increasing the decay of organic matters in the soil. (*Note by Dr. Ebermayer.*)

The evaporation at night is from a third to a half less than in the day time, and by day it is greater in the sun than in the shade. Under a clear sky, with a north and northeast wind,[1] even the soil will dry quickly. The favorable effects from loosening a wet soil, and the necessity of rolling a light one, in dry weather, explain themselves from the above. The moisture evaporated from a water-surface is carried to other places by currents of wind; and a large part of the moisture in the air is brought from the sea. It is, under favorable conditions, returned to the earth as snow or rain.

Having shown that the forest-air, in the yearly mean, is colder, and relatively moister in the woods than in the fields, and the force of the winds being much less in the former, it follows that in the forest less water evaporates from the ground than in the fields. According to observations in the year 1858–'59, the evaporation from a free water surface, in Paris square feet, at the several stations, amounted to the following, in Paris cubic inches:

	Seeshaupt.	Rohrbrunn.	Johannes-kreuz.	Ebrach.	Altenfurth.	Aschaffen-burg.
In the fields	2,642.00	3,567.00	3,170.00	3,687.37	2,834.75	2,571.00
In the woods	545.00	1,063.00	1,471.10	1,484.33	1,256.00	....
Difference	2,097.00	2,504.00	1,698.90	2,203.04	1,578.75	....

As a mean general average for all observations, the evaporation was:

	Paris cubic inches.	Paris lines.	Millimeters.
In the fields	3,180.42	265.03	597.93
In the woods	1,163.88	96.99	215.64
Difference	2,016.54	168.04	372.29

In the forests, the evaporation from a free water surface was, in the yearly average, 64 per cent. less than in the open fields; or in other words, where 100 cubic inches would be evaporated from a square foot in an open exposure, but 36 inches would be changed to vapor in the woods. This reduced evaporation in the latter is, of course, the principal cause of the greater moisture of the soil in wood-lands.

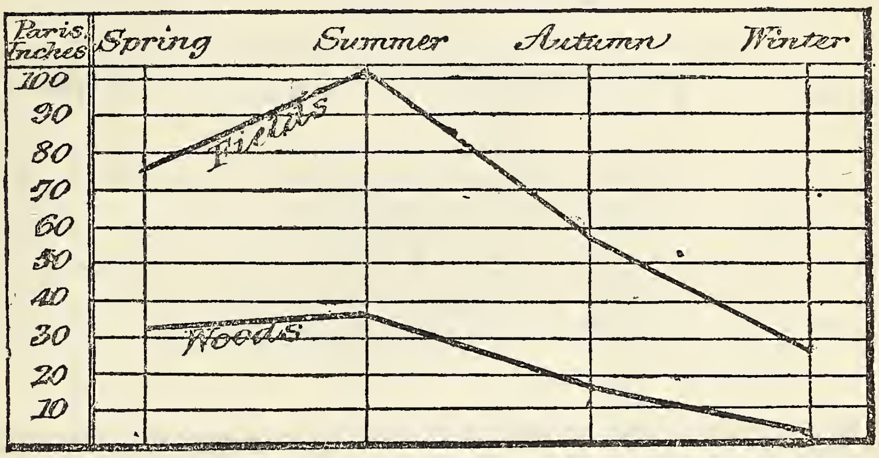
Amount of evaporation from a free water surface at different seasons.

Evaporation, like the temperature and moisture of the air, reached its maximum in summer, followed in descending order by spring, autumn, and winter. The evaporation was most at the most elevated station.

[1] This is said of Germany; but with us, the drying winds are north, northwest, west, and especially in the Western States, in summer, the southwest. In all cases, it may be stated as the general rule, that winds coming from the interior of continents are dry, and that ocean winds are moist.

Evaporation at different seasons, in cubic contents and depths.

Seasons.	In cubic Paris inches.			In linear Paris inches of depth.			Percentage of difference to amount in open fields.
	In open fields.	In woods.	Difference.	In open fields.	In woods.	Difference.	
Summer	1,223.30	428.54	794.76	101.94	35.71	66.23	64.90
Spring	907.63	390.67	516.96	75.64	32.56	43.08	57.00
Autumn	610 74	203.18	407.56	50.89	16.93	33.96	66.70
Winter	313.45	110,56	202.89	26.12	9.21	16.91	64.80
Average for the year	763.78	280.74	483.04	63.65	23.60	40.05	62.90



Difference of evaporation in open fields and in woodlands at different seasons.

The evaporation is, therefore, four times as great in summer as in winter. Nothing could give us a clearer idea of the influence of woodlands upon the evaporation of water than the above figures.

Clearings must, therefore, accelerate evaporation in a high degree, particularly in summer, and most in warm seasons and climates, and from these facts alone we can see the great importance of the forests in retaining the moisture of the earth and the abundance of springs during the warm season. A closer examination of the above figures shows further the interesting result *that the evaporation of water in the forest*, at all seasons, is about 63 per cent. less than in the open fields. This is much more surprising, as we have hitherto shown that the mean temperature of the air in the forest, in the annual result, is but little below that of the fields, so that if this evaporation depended solely upon the temperature of the air it could have but slight influence, especially in the winter months. But as, in fact, we find the relative influence in winter almost as great as in summer, it follows that the amount and rapidity of evaporation depend a great deal more upon the motion of the air than upon the temperature.

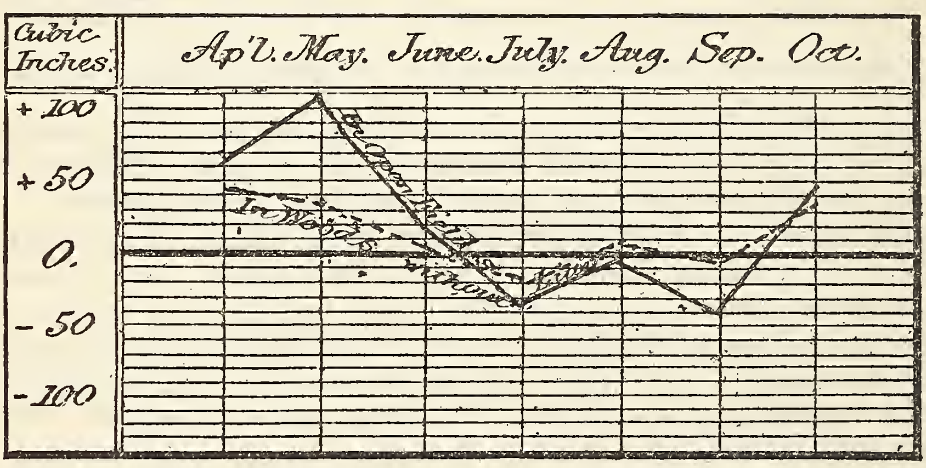
The evaporation of water in the soil depends upon the same factors as those of a free water surface, and takes place generally in accordance with the same laws. If the process goes on faster or slower, it will be found to depend upon the formation of the soil, the degree of looseness, the kind of covering, location, and force and direction of the wind. In these experiments the soil was always saturated with water by capillary attraction, so that only the larger spaces contained air. It was not attempted to ascertain the evaporating power of different kinds of soil under circumstances otherwise similar, but merely to find the influence of the forest and the litter strewn upon its surface upon the

evaporation of moisture in the soil. A comparison of results shows that upon the whole, a stratum of soil half a foot deep, saturated with water, will furnish more aqueous vapor to the air than a free water surface of the same area. At some stations, and in some months, it was more, and in some less, which is probably due to differences in the motion of the air over the surface.

The importance of the latter is seen from the circumstance that with decreased motion of the air in the forests, the evaporation of water in the soil is always greater than from a free water surface. In the general mean the evaporation from the soil in different months was greater or less, as shown by the following table:

Greater or less evaporation from a square foot of water than from the same area of saturated soil, in cubic inches.

Months.	In open fields.	In woods without litter.	Months.	In open fields.	In woods without litter.
April, 1869	+ 63.50	+40.92	August, 1868	−101.90	+13.32
April, 1870	+ 38.85	+84.40	August, 1869	− 3.81	+ 2.72
May, 1869	+106.78	+35.11	August, 1870	− 23.26	− 4.95
May, 1870	+ 13.14	−15.91	September, 1868	−138.04	−33.21
June, 1869	+ 18.38	+ 0.18	September, 1869	− 39.03	− 1.75
June, 1870	+ 27.66	+ 5.00	September, 1870	+ 97.27	− 2.80
July, 1869	− 31.99	−15.66	October, 1868	+ 32.07	+34.88
July, 1870	− 65.75	− 2.25	October, 1869	+ 51.72	−12.45



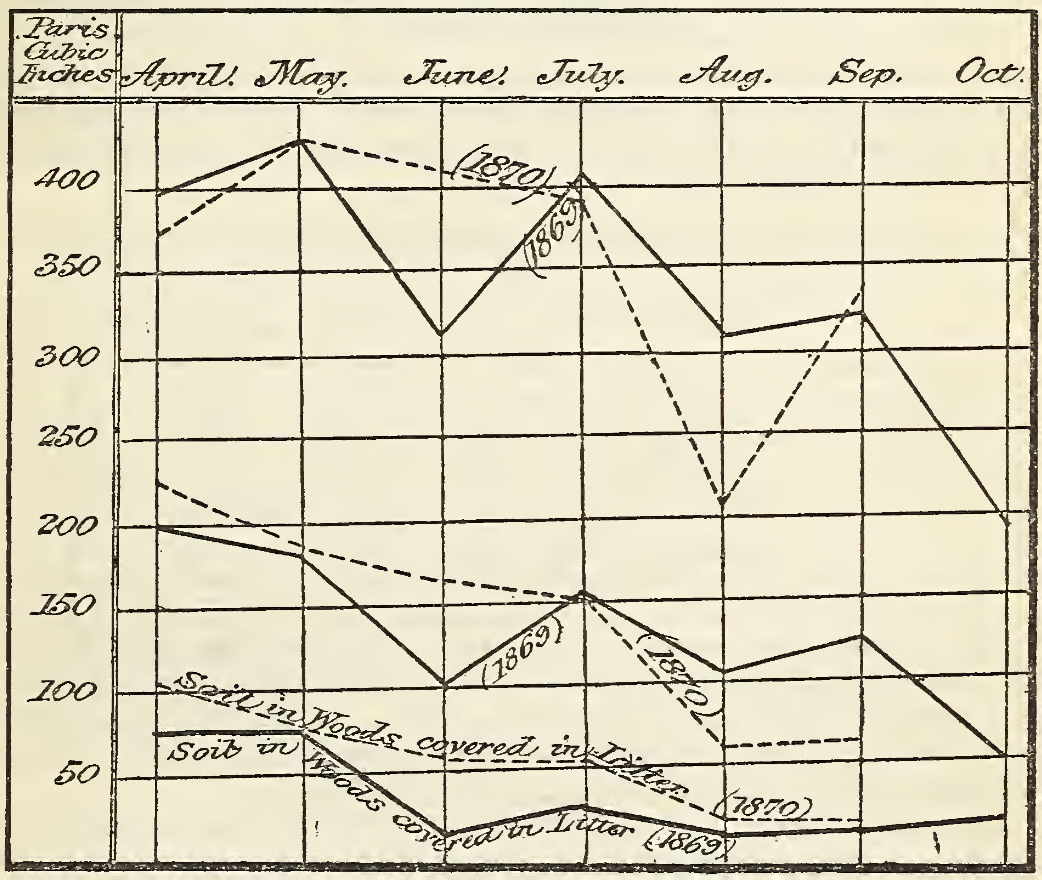
Comparative evaporation from water and from saturated soil in open fields and in woodlands.

Influence of forests on the evaporation of water from soil free of litter.

To determine the influence of forests on the evaporation of water in the soil, independently of the litter, a comparison was made between the amount evaporated from a stratum of uncovered soil half a foot deep in the fields and a like stratum in the forests. The average mean shows that the evaporation in the forests was less than in the fields, as follows:

Difference in evaporation of moisture from saturated soil, in cubic inches, from a square foot of surface.

Months.	Between uncovered fields and uncovered woods.	Between uncovered and litter-covered woods.	Between uncovered fields and litter-covered woods.	Months.	Between uncovered fields and uncovered woods.	Between uncovered and litter-covered woods.	Between uncovered fields and litter-covered woods.
April, 1869	198. 50	122. 50	321. 00	August, 1869	201. 28	75. 62	276. 90
April, 1870	146. 81	123. 69	270. 50	August, 1870	242. 50	95. 50	339. 00
May, 1869	273. 29	92. 54	365. 83	September, 1869	202. 72	81. 04	283. 70
May, 1870	252. 50	109. 80	362. 30	September, 1870	148. 19	31. 33	179. 52
June, 1869	218. 96	63. 52	282. 78	October, 1869	143. 74	25. 03	168. 77
June, 1870	251. 20	97. 80	349. 00	October, 1870	262. 42	37. 50	299. 92
July, 1869	255. 77	96. 15	351. 92				



Differences between evaporation in open fields and in woods, and the effect upon evaporation from the removal of litter.

The above diagram represents the differences stated in the foregoing table. The lower pair of lines is from the middle column, and shows the excess of evaporation from naked soil in the woods over the same soil in woods where the leaves and other litter are allowed to remain.

The middle pair of lines (simply marked 1869 and 1870) refers to the first column of the table, and shows the differences between uncovered soil in the fields and uncovered soil in the woods.

The upper pair of lines (also marked 1869 and 1870) refers to the third column of the table, and shows the differences between the evaporation from uncovered fields and litter-covered woods.

The influence of the forests upon evaporation is, therefore, as great as that on a free water surface, and in the warmer months—May, June, and July—they assist more in retaining the moisture than in the other months. The loss of moisture of the soil in the summer season of 1869 (during the period of vegetation), in the average mean, was, in the for-

est, 63, and in the same period in 1870 61 per cent. less than in the open air, a result in perfect harmony with the influence of the forest on the evaporation of a free water surface. In some months the evaporation of moisture in the soil in forests is one-third, and sometimes even only a fourth, of that in the fields. The influence of forests is especially shown after a long-continued rain, as in August and September, 1870.

Influence of the litter of forests upon the evaporation from the soil.

This is doubtless one of the most important questions in forestry. For the purpose of determining it numerically two atmometers were put up in dense woods, each filled with half a foot of earth, capillarily saturated, one being covered with litter in normal condition of leaves or moss, and the other not covered. The mean of all observations is shown in a subsequent table.

Evaporation from soil in the open fields, compared with that from litter-covered wood-soil.

In a forestal and economical point of view, it is of great interest to know the influence which forests strewn with litter have upon the retention of moisture in the earth. The observations in this respect show the following conclusions.

Evaporation from litter-covered wood soil compared with that from naked soil in the open fields.

	April.	May.[1]	June.	July.	August.	September.	October.
Litter-covered wood soil:							
1869	78.00	72.32	37.48	54.85	32.52	38.54	25.00
1870	102.25?	76.50	61.70	55.25	28.92	28.75	....
Naked soil of fields:							
1869	399.00	438.15	319.96	406.77	309.42	322.30	193.77
1870	372.75	438.80	410.70	394.25	208.44	328.67	....
Difference:							
1869	321.00	365.83	282.48	351.92	276.90	283.76	168.77
1870	270.50	362.30	349.00	339.00	179.52	299.92	....

In other words, the evaporation is from three to eleven times greater in the fields than in litter-covered woods, the general average being 7.2 times as great in 1869, and 7 times in 1870. From these direct observations we are enabled to express the following general conclusions so far as relates to the months from April to October:

1. The forests alone, without litter, diminish the evaporation of water in the soil, as compared with the open fields (in the mean of the two years observed), 62 per cent.

2. The litter covering in the forest diminishes the evaporation still further 22 per cent.

3. Forests and litter together reduce evaporation 84 per cent.

4. In litter-covered forests the evaporation is 60 per cent. less than in uncovered forest soil.

While in the open fields 100 parts of water evaporate from saturated naked earth, the uncovered soil of woods yield but 38 per cent. and the litter-covered soil but 15 per cent. Or, calling the loss from uncovered wood soil 100, the amount from the same covered with litter is 40 per cent.[2]

[1] The relatively large amount in May, as compared with other months, is explained by the fact that, at the beginning of observations in each year, the soil at some stations was not thoroughly saturated with water.

[2] Observations made near the Forest School at Nancy led to results corresponding in the main with those above given, the amount in the fields being about five times greater than in the litter-covered woods.

Thus, by direct observation, it being shown, with certainty, that the evaporation in forests covered with litter is very much less than that of naked soil under like circumstances, there can be no longer a doubt that not only the forests, but also the litter that covers the surface, contribute largely to the retention of moisture in the earth and to the feeding of springs. The total mean loss of moisture in litter-covered forest-soil during the months from April to October, inclusive, 1869, was 62 per cent., and in 1870, 58 per cent., less than in soil free from litter. If we compare these percentages with the preceding, we find this most interesting result: that the litter covering contributes as much to the retention of moisture in the soil as forests themselves. In very rainy seasons this influence is less than in dry years. From this it is seen how important it is to retain a protecting covering of moss or leaves on the soil, especially upon mountain slopes, where, without litter, or even without woods, but very little water penetrates the soil, the water for the most part running off into the valleys.

As these differences are most in warm weather, so they must be greatest in warm countries.

Rain-fall in the open fields and in the forests, and the influence of forests upon the amount of rain.

A knowledge of the amount of precipitation (rain, snow, fog, and dew) during the year has a practical as well as a scientific interest, because not only is the height of mean water in our rivers governed by the amount of rain and snow, but also the yield of our crops is largely dependent upon the amount of moisture in the earth. Each plant, during its life, uses a considerable amount of water as compared with its weight, and this is derived mainly from the soil. In great drought the plant either dies, or is developed but poorly, forming few roots and few leaves and seeds. In fertilized soils it may thrive better, but without sufficient moisture and its vital powers decline. According to the careful investigations of Hellriegel it appears that, in sandy soils and in dry regions, the size of our crops depends more upon the amount and distribution of rain than any other factor. Although generally a greater warmth of the air acts favorably upon the development of plants, it certainly does no service unless the soil receives a corresponding amount of rain.

The action of the water begins with germination, and continues till the formation of the fruit. In the early summer months the grass will wither in the meadows, the herbs and young plants will dry up, the leaves and blossoms of trees will droop, and the half-ripe fruit fall. But how suddenly will plants revive when a long-delayed rain falls on the arid earth! The forester knows from experience the injuries caused by drought. He knows that forest vegetation demands a certain minimum of yearly precipitation, which must be relatively greater in warmer and drier climates and soils. He also knows that the growth of wood is greater in moist and moderately warm years than in hot and dry seasons; in fact, the growth of forest trees and their propagation is governed in a very large degree by the distribution of moisture.

The great claims which trees make upon the moisture in the soil are explained by the circumstance that they contain a large amount of water, which forms the principal part of their sap, and a part of the wood fiber, cells, and other organic parts. Starch, chlorophyl, &c., are saturated with water. It is by its agency that the functions of nutrition and growth are carried on. This want is greatly increased by the

enormous evaporation constantly going on through the leaves, &c., during the growing season, especially in the day-time, which passes off into the air as an invisible vapor, and must be replenished from the soil through the agency of the roots, or they wilt and die. The tree is, in one sense, a stream of water, which during the growing season is moving from the fibers of the roots through the outer body of wood into the limbs and branches and into the leaves. The forests thus withdraw a great amount of water from the soil and give it off as vapor. In winter the process is partially suspended, but still there is a certain degree of activity in the roots. They lay up a supply of aliment in the wood which serves to keep them alive at a time when grass and herbs would die, and from the depth to which the roots penetrate, they are able to draw water from deeper strata which never become dry, and may thus be able to endure the driest seasons.

The amount of water which plants and trees need to sustain life, depends mainly upon the growth and evaporation. The latter differs in the same plant, according to age, size, and location, as well as conditions of soil, amount of light, and motion of the air. We have as yet no reliable results as to the amount of water which different forest plants and trees under various circumstances lose by evaporation. This is a subject which deserves our attention in the highest degree, and furnishes a rich subject for forest-experimental stations. While Unger found that water would evaporate three times the amount of a plant of the same surface, Schleiden concludes[1] that a forest evaporates at least three times as much water as a water-surface of like area. According to Hartig, a forest evaporates less than free water or wet earth. In hot summer days some plants will evaporate their own weight. In fact, forests afford, and some species of trees more than others, a kind of vertical drainage of water from the soil.[2]

With respect to the relative amount of water falling in the fields and forests, it was found uniformly greater at the surface of the earth in the former than the latter, for the manifest reason that a part was intercepted by and evaporated from the foliage of the trees. The percentage in the woods, as compared with the fields, varied in different years by seasons, from 40 to 90, being on the general average of all stations, and, for the whole period, least in spring and most in winter.

Percentage of rain and snow reaching the earth at different seasons in the woods, as compared with adjacent fields.

Stations.	Spring.	Summer.	Autumn.	Winter.	Mean.
Duschlberg	68	73	79	71	73
Seeshaupt	67	68	73	77	72
Pronenhof	43	64	57	72	59
Rohrbrunn	83	80	82	86	83
Johanneskreutz	79	84	79	75	78
Ebrach	70	67	73	81	73
Altenfurth	64	69	68	62	66
Mean	72	72	73	75	72

[1] *Baum und Wald,* Leipzic, 1870, p. 46. Much information upon the movement of water in plants will be found in the *Sach's Text Book of Botany,* p. 598–614, where citations to other authorities will also be found.

[2] Dr. Ebermayer proceeds to discuss the subject of evaporation from growing plants with considerable detail, citing many authorities. Our space does not admit of a fuller consideration of the subject.

These results will be found to agree with those obtained at other stations, and the rule would doubtless apply to all countries and to every period of time.[1]

Effect from removing the litter, and the result from large clearings, upon the moisture of the soil.

The foregoing statements show how closely related in a country, are its wealth in forests and water (as shown by the great influence of the former), and the litter that covers their surface—to the evaporation and moisture. It therefore need not surprise us, that springs and brooks dry up or flow only periodically, and that the mean height of water in rivers and large streams lessens when large surfaces are cleared up, or that springs flow more abundantly and regularly when, by replanting, the extent of forests is increased. The influence of forests and of litter-covering on the moisture of the soil, founded upon these observations, may be expressed not only in percentages, but we may be allowed to draw conclusions from small to great, as they afford the means for estimating the loss of water in the soil, caused by large clearings and the taking off of litter from any given surface.

These figures apply only to soils capillarily saturated with water—a condition which exists only after heavy rains. If such a soil is exposed to wind and sunshine, it dries up without receiving, as it did from the apparatus, a full supply from below, to replace that which has been lost. The natural soil is therefore in a less favorable condition for evaporation than in the experiments; but we may feel the more satisfied with our data, because the comparisons have been made under similar conditions as to saturation, and observations could be made with greater accuracy than where the moisture was changeable. Total average evaporation in six months is shown by the following table:

Total evaporation from April to September, inclusive, from a square foot of surface.

Years.	In open fields.		In woods without litter		In woods with litter.	
	Cubic inches.	Depth in inches.	Cubic inches.	Depth in inches.	Cubic inches.	Depth in inches.
1869	2,195.60	15.24	845.08	5.86	313.71	2.18
1870	2,153.61	14.95	848.99	5.89	353.37	2.45
Mean	2,174.60	15.09	847.03	5.87	333.04	2.31

From this it follows, that from an acre of ground the following amount of water was evaporated in six months from saturated soil:

From open fields, 54,450 cubic feet = 3,403,125 pounds = 1,701.5 tons.

[1] Observations made in France by M. Fautrat, and reported to the Academy of Sciences, showed that in 1874, in a dense wood of 500 hectares, a rain-gauge fixed on the top of a large poplar, received much more water than one of similar height 300 meters beyond the borders of the woods. These experiments, continued two years longer, had confirmed the first results; and an instrument placed over the *Pinus sylvestris*, in a dense forest, at 12 meters elevation, was found to receive 10 per cent. more water than in the fields at the same height. "These results," says the reporter, "show evidently that the pines have the property of condensing the vapors, and this in higher degree than in leaf-woods; the difference in their favor being more than 5 per cent. when compared with observations made over oaks and hornbeams." Hygrometrical observations also showed a considerable excess of moisture within the pine forest, as well as over it, as compared with fields, and that the evaporation under pines was considerably more rapid than in a deciduous forest. These results prove the services of pine woods on heated sands and on soils where a want of water has rendered the surface sterile. In such cases the roots may often reach a humid stratum sufficient for the trees, and the atmosphere receives a portion of this moisture to the benefit of the agricultural regions adjacent.

From woods without litter, about 21,780 cubic feet = 1,361,250 pounds = 680.6 tons.

From woods with litter, about 8,700 cubic feet = 544,495 pounds = 272 2 tons.

The preceding figures, which express the mean of all observations, and the influence of the forests in the whole, will vary of course in different places, according to extent of forest, its location, kind of timber, and other circumstances. It will, however, be found in all cases that the influence of the forest on the evaporation of water is greater than on the temperature of the air, and it is affected chiefly by the greater or less movement of the air. Daily experience shows that currents of air will increase evaporation, and dry winds more than those that are moist. It may be considerable even with a very low temperature, in a dry, strong wind.

Relation of the evaporation from a wooded and unwooded soil; or the influence of the forest on the evaporation of water in the soil.

Having shown the differences of evaporation from a free water surface, the question follows, as to how far the presence or absence of woodlands may affect the evaporation from the soil. There is no more important question in the climatology of forests. The results of only the full years 1869 and 1870 are available for the study of this question, and the average mean of these years shows that from a Paris square foot of soil half a foot deep, saturated with water by capillary attraction, the following results were obtained:

Months.*	(1.)	(2.)	(3.)	Differences between—			Percentages (evaporation from soil in open woods being 100).		
	Naked soil in open fields.	Naked soil in woods.	Soil in woods covered with litter.	1 and 2.	1 and 3.	2 and 3.	Naked soil in woods.	Soil in woods covered with litter.	Difference between the preceding
April, 1869	399. 00	200. 50	78. 00	199. 50	122. 50	321. 00	50. 3	19. 5	30. 8
April, 1870	372. 75	225. 94	102. 25	146. 81	270. 50	123. 69	60. 6	27. 5	33. 1
May, 1869	438. 15	164. 86	72. 32	273. 29	365. 83	92. 54	37. 6	16. 5	21. 1
May, 1870	438. 80	186. 30	76. 50	252. 50	362. 30	109. 80	42. 4	17. 4	25 0
June, 1869	319. 96	101. 00	37. 48	218. 96	282. 48	63. 52	31. 6	19. 8	11. 8
June, 1870	410. 70	159. 50	61. 70	251. 20	349. 00	97. 80	38. 9	15. 0	23. 9
July, 1869	406. 77	151. 00	54. 85	255. 77	351. 92	96. 15	37. 1	13. 4	23. 7
July, 1870	394. 25	150. 75	55. 25	243. 50	339. 00	95. 50	38. 3	13. 9	21. 4
August, 1869	309. 42	108. 14	32. 52	201. 28	276. 90	75. 62	34. 9	10. 5	24. 4
August, 1870	208. 41	60. 25	28. 92	148. 19	179. 52	31. 33	28. 9	13. 9	15. 0
September, 1869	322. 30	119. 58	38. 54	202. 72	283. 76	81. 04	37. 1	11. 9	25. 2
September, 1870	328. 67	66. 25	28. 75	252. 42	299. 92	37. 50	20. 1	8. 7	11. 4
October, 1869	193. 77	50. 03	25. 00	143. 74	168. 77	25. 03	25. 1	12. 9	12. 2

* These observations can only be made from April to October, because freezing interrupts the working of the apparatus.

The figures in this table are from the means as given on pages 204 and 206 of the tabular portion of Dr. Ebermayer's work.

The effect of rains and snows upon the moisture of the soil.

Of the rain and snow that fall upon the earth, a part runs off on the slopes of the surface; another part evaporates, and a part penetrates into the earth and is distributed in all directions by capillarity and hydrostatic pressure. Some of the latter is retained in the pores of the

soil, and some sinking deeper finally reaches an impervious layer, and again reappears in springs. Even in the heaviest rains, the water enters the soil at first but a few centimeters in depth, and after the capillary spaces in the upper strata are filled, the water is absorbed deeper, and by hydrostatic pressure is carried to greater depths. In cultivated soil where there is water in the ground, it is brought to the surface by capillary attraction. The chemical and physical condition of the soil and the kind of covering, has a great influence upon the amount of rains absorbed, and of water evaporated, and these must change considerably according to the seasons. Short, heavy falls of rain, especially on slopes, are found to give less water to the soil than those that are gentle and protracted, even if the latter furnish actually less water, but interrupted showers wet the ground less than continuous ones, even if of greater amount, from the evaporation that takes place between them.

Effect of woodlands upon Ozone.

Observations were made to determine the effect of forests upon the amount of ozone in the air, the result of which showed that there was more in the country than in the cities, more in fields near the border of woodlands than within their shade, and more at the level of the tree-tops than near the ground. It was most perceptible in winter, next in spring, less in autumn, and least in summer. No difference was observed by Dr. Ebermayer between evergreen and deciduous forests, but M. Fautrat, in France, found the amount of ozone somewhat less under resinous woods than under deciduous forests. The latter observer agrees, however, in the statement that there is less within than on the borders of a forest. According to the records made at the Bavarian stations, ozone is more perceptible at higher than at lower elevations, and was least apparent in the open country at a distance from forests.[1]

PRUSSIA.

Forest-meteorological stations were established in Prussia and in Alsace-Lorraine in April, 1874, and the system, consisting of seven stations in the former and three in the latter, is now complete.[2] Since January, 1875, observations have been published regularly every month, and the annual report for 1875 has appeared.[3] The observations are made as in

[1] The late Dr. Charles Smallwood, of Montreal, well known from his careful meteorological studies, remarked concerning ozone, that "there is no condition of the atmosphere appreciable by our instruments that indicates the presence of ozone except the presence of vapor or humidity." It follows that any cause capable of increasing the relative amount of vapor in the atmosphere tends to the development of this substance.—(*On Ozone, and on the Meteorology of the Vicinity of Montreal*, 1857, p. 8.)

The records of Bérigny, of Versailles, show the influence of the vicinity of forests and other vegetation on the amount of ozone. The maximum is in May, when vegetation is active, and the minimum in November, when the decomposition of the dead leaves and plants is the greatest.—(*Fox on Ozone and Antozone*, p. 100.)

Individuals are sent to the pine forests of Prussia and other countries in order that they may breathe the highly ozonized exhalations of the coniferæ. The beneficent effects of such a residence in pulmonary affections may, perhaps, be due to some extent, to the direct influence of the turpentine diffused through the air.—(*Ib.*, 113.)

[2] Three new stations were to be established in 1876–'77. In the selection of places, care was taken that the soil, aspect, and general character of surface, and in the woodland stations the timber-growths as to age and kind, should be as nearly alike as possible.

[3] *Jahrsbericht über die Beobachtungs-Ergebnisse der im Königreich Preussen und in den Reichslanden eingerichteten förstlich-meteorologischen Stationen.* Berlin, 1877, pp. 91. The report for 1876 has not come to our notice, and we do not know that it has been published.

Bavaria, at two places at each station, the open fields and under woodland shade, and twice daily, at 8 a. m. and at 2 p. m. They include records upon the temperature of the air at 1.5 meters above the earth and at the height of the tree-tops, humidity, evaporation, rain and snowfall, temperature of the soil at the surface and at the depths of 0.15, 0.3, 0.6, 0.9, and 1.2 meters; also, barometer, direction and force of winds, kind and amount of clouds, and general characteristics of the day. They also include notices of all meteorological phenomena observed, and records of first appearance of flowers, leaves, &c., and other events in animal and vegetable life that depend upon the seasons. The arrangement of instruments and mode of taking observations are entirely similar to those in Bavaria, as already described, with the exception of those relating to loose materials upon the ground in the woods, and the temperature within the body of the trees, which are omitted, while observations are added for obtaining the temperature and moisture of the air at the level of the tree-tops.

These observations are too recent to afford important results, and but one of the stations the first year gives results through the entire period. The thermometers are of the centigrade scale, and metrical measures are adopted throughout These observations are under the direction of Dr. A. Müttrich, professor of experimental physics and meteorology in the Royal Forest Academy at Neustadt-Eberswalde.

SOME RESULTS OF ONE YEAR'S OBSERVATION (1875) AT THREE PRUSSIAN FOREST STATIONS.

[The stations in the following tables are designated by numbers, as follows:
1. *Friedrichsrode*, latitude, 51° 22′; longitude, 28° 14′ east; elevation, 353 meters.
2. *Hollerath*, latitude, 50° 27½′; longitude, 24° 3½′ east; elevation, 612 meters.
3. *Carlsberg*, latitude, 50° 28′; longitude, 34° 2′ east; elevation, 690 meters.
The timber at station 1 was beech, 65 to 85 years old; and at 2 and 3 pines, 45 years old.]

Temperatures. (Centigrade.)

Months.	In open fields.			In woods, at 1.5 meters high.			In woods, at tree-tops.		
	1.	2.	3.	1.	2.	3.	1 (8 meters).	2 (8½ meters).	3 (11 meters.)
January	0.45	1.37	− 3.65	0.24	1.18	− 3.87	0.50	1.23	− 3.36
February	− 5.05	− 3.85	− 9.03	− 4.99	− 4.18	− 9.09	− 4.98	− 4.24	− 8.37
March	− 0.60	0.61	− 3.70	− 0.37	0.06	− 4.01	− 0.37	0.01	− 3.15
April	7.56	8.25	4.31	7.92	7.24	2.87	7.61	7.22	4.51
May	13.68	13.70	12.44	13.30	12.32	10.61	13.31	12.45	12.15
June	17.53	15.67	18.24	16.16	14.31	17.55	16.59	14.58	18.05
July	18.51	16.15	16.89	16.67	14.68	15.82	17.22	14.97	16.39
August	20.58	18.10	18.27	18.65	17.89	16.72	19.29	16.95	18.12
September	14.50	14.97	11.58	13.27	13.85	9.72	13.98	14.04	11.55
October	5.07	6.12	4.11	4.86	5.56	3.56	4.86	5.51	4.15
November	0.79	1.57	− 1.47	0.81	1.29	− 1.73	0.77	1.16	− 1.44
December	− 2.81	− 1.18	− 7.01	− 2.91	− 1.45	− 6.89	− 2.71	− 1.41	− 6.66
Mean	7.52	7.62	5.08	6.97	6.89	4.27	7.16	6.87	5.16

By comparing the above observations it will be seen that the difference between fields and woodlands was more considerable in the growing months, and for the general average of the year, the woods were cooler than the fields, except in the winter, when the woods were warmer than the open fields.

The temperature at the tree-tops was in most cases above that of the air below, and the difference was much greater in summer than in winter. It is to be further noticed that the range of difference was considerably most with respect to the beech woods, and from June to September, the greatest difference appearing in August.

Absolute moisture. (Millimeters.)

Months.	In open fields at 1.5 meters.			In woods at 1.5 meters.			In woods at tree-tops.		
	1	2	3	1	2	3	1	2	3
January	4.54	4.78	3.59	4.54	4.88	3.57	4.55	4.81	3.58
February	2.94	3.13	2.35	2.93	3.22	2.36	2.95	3.23	2.36
March	4.09	4.26	3.40	4.06	4.21	3.35	4.07	4.25	3.28
April	5.28	4.88	4.76	5.29	4.96	4.71	5.21	4.98	4.65
May	8.30	7.96	7.23	8.23	7.78	7.38	8.15	7.92	7.01
June	11.19	9.57	10.75	11.27	9.54	10.84	11.19	9.61	10.37
July	12.16	10.70	10.35	11.69	10.57	10.64	11.63	10.60	10.07
August	12.81	11.99	10.58	13.08	11.95	10.92	13.06	12.00	10.46
September	9.35	9.10	7.49	9.49	9.33	7.51	9.57	9.34	7.46
October	6.28	6.38	5.90	6.28	6.46	5.91	6.33	6.34	5.87
November	4.68	5.06	4.03	4.80	5.13	4.09	4.81	5.04	4.02
December	3.79	4.30	2.95	3.76	4.28	2.97	3.79	4.23	2.96
Mean	7.12	6.93	6.11	7.12	6.86	6.19	7.11	6.86	6.01

Relative moisture. (Percentages.)

Months.	In open fields at 1.5 meters.			In woods at 1.5 meters.			In woods at tree-tops.		
	1	2	3	1	2	3	1	2	3
January	92.7	91.9	96.4	94.2	94.6	97.8	92.9	93.8	94.7
February	92.6	89.7	97.1	92.5	94.0	99.3	93.0	95.5	93.8
March	90.1	86.4	94.3	88.6	88.6	94.1	89.0	91.2	86.6
April	69.3	62.5	76.0	67.9	66.1	82.7	68.0	67.0	73.0
May	72.3	69.2	67.4	73.5	73.1	76.6	72.1	74.2	66.1
June	76.2	73.9	70.0	82.6	79.0	73.0	80.6	78.7	67.9
July	76.8	78.5	72.5	82.5	84.5	79.4	78.7	83.3	72.7
August	72.0	78.7	68.9	81.3	84.2	77.9	77.8	83.1	68.4
September	75.9	72.5	73.2	83.4	78.5	82.2	80.3	78.0	72.5
October	93.2	87.9	93.0	93.5	92.0	96.0	94.3	90.9	91.6
November	94.2	94.5	94.6	95.3	96.5	97.2	95.3	96.5	93.5
December	95.9	97.1	98.4	96.2	97.8	98.9	95.6	96.9	96.7
Mean	83.4	81.9	83.5	85.9	85.7	87.9	84.9	85.8	81.5

It appears from the foregoing tables that but very slight difference appears between the *absolute* moisture of the field and woods, the deviation in no case amounting to a millimeter of pressure.

But with the *relative* moisture, the case is different, the greater percentage being in favor of the woods, and the summer months. It will be further seen that there are two minima of relative moisture, one in April and the other in August, the intervening period being somewhat higher, but not so high as in the winter months.

Evaporation. (Millimeters.)

Months.	In open fields.			In woods.			Difference.		
	1	2	3	1	2	3	1	2	3
January	11.8	3.4	3.7	5.6	5.1	1.3	6.2	—1.7	2.4
February	9.3	6.8	4.9	5.4	4.1	1.5	3.9	2.7	3.4
March	14.8	13.0	11.2	8.1	6.8	4.6	6.7	6.2	6.6
April	39.4	38.9	30.2	26.5	22.1	10.8	12.9	16.8	19.4
May	50.6	40.2	48.5	26.2	20.8	18.0	24.4	19.4	30.5
June	68.0	41.0	56.6	21.7	19.7	28.4	46.3	21.3	28.2
July	55.8	32.6	41.6	17.7	13.8	18.1	37.9	18.8	23.5
August	53.6	37.8	54.9	22.5	16.6	23.3	31.1	21.2	31.6
September	49.5	39.2	36.5	16.9	19.4	11.5	32.6	19.8	25.0
October	15.5	13.3	10.4	5.6	10.3	2.1	9.9	3.0	8.3
November	9.0	2.3	6.2	4.4	4.2	1.1	4.6	—1.9	5.1
December	7.0	2.7	1.2	2.9	0.7	0.5	4.1	2.0	0.7
Total	384.3	271.2	305.9	163.5	143.6	121.2	220.6	127.6	184.7

These results strongly confirm the fact shown by the Bavarian records as to the extraordinary increase of evaporation in summer, and the great excess of its amount in the open fields, as compared with woods.

Rain and snow fall. (Millimeters).

Months.	In open fields.			In woods.			Difference.[1]		
	1	2	3	1	2	3	1	2	3
January	46.4	142.0	66.5	46.3	125.3	85.4	0.1	16.7	18.9
February	23.7	25.0	57.0	25.2	25.7	77.1	—1.5	—0.7	—20.1
March	38.6	20.9	54.3	22.5	20.6	51.6	16.1	0.3	2.7
April	44.6	13.6	24.1	36.5	3.7	16.7	8.1	9.9	7.4
May	66.8	63.1	68.4	51.5	5.2	30.6	15.3	27.9	37.8
June	80.5	115.0	61.0	57.4	49.0	31 1	23.1	66.0	29.9
July	54.4	197.6	235.2	42.5	133.5	176.0	11.9	64.1	59.2
August	49.8	95.1	62.6	35.6	60.4	52.1	14.2	34.7	10.5
September	62.9	69.4	68.0	43.3	33.4	60.4	19.6	36.0	7.6
October	73.1	57.4	99.8	54.6	30.9	119.7	18.5	26.5	—19.9
November	114.0	187.2	104.7	103.9	124.4	100.5	10.1	62.8	4 2
December	56.8	75.3	74.3	61.9	59.5	89.8	—5.1	15.8	—15.5
Total	711.6	1,061.6	975.9	581.2	701.6	891.0	130.4	360.0	122.7
Snow	110.4	135.2	292.9	129.5	102.4	313.8	—19.1	32.8	—20.9

[1] The minus sign in these columns shows that there is an excess in the woods, as compared with the fields.

The amount of pecipitation that reaches the ground appears from this table to be very considerably less in the woods than in the fields, with two or three notable exceptions from causes not shown. This difference is somewhat unequally distributed, but on the whole much greater in the summer months, as will doubtless appear more clearly when the average of several years' observations can be shown.

SWITZERLAND.

Comparative observations in fields and forests in the canton of Berne, Switzerland.

A series of meteorological observations was begun in January, 1869, at three different stations in the canton of Berne, Switzerland, under the direction of the *kantonsforstmeister*, the conditions of placing and time and mode of observing the instruments being alike. At each station one set of instruments was in the open fields, and the other in the woods, as in the observations above described. The stations were as follows:

1. *Interlaken* (Brückwald Forest): elevation 620 meters; timber *larch*, which at the beginning of observations was about 50 years old; elevation of place for observing temperature, &c., of tree tops, 15 meters.

2. *Berne* (Löhrwald Forest): 593 meters above sea level; timber *red fir*, which in 1869 was about 40 years old. Elevation of place for observing temperature, &c., of tree tops, 9 meters.

3. *Pruntrut.* (Fahywald Forest): 450 meters above sea level; timber *beech*, which in 1869, was 50 to 60 years old. Elevation of place for observing temperature, &c., of tree tops, 14 meters.

The observations included the temperature of the air at breast-high, and in the woods at the tree tops; percentage of moisture, extremes of temperature, temperature of the soil at the surface of the earth, and at depths of 0.3, 0.6, 0.9, and 1.2 metres below, amount of rain and melted snow, number of rainy, snowy, and cloudy days, and prevailing direction of the winds. Apparatus was provided for measuring evaporation

and percolation of water, but we are not aware that the results of either of these have been published except irregularly. The temperature of trees was also observed by placing thermometers in holes bored at breast-high and in the tree tops at the height of 15 meters at the first station, at 9 meters at the second, and at 14 at the third.

Besides these instrumental stations, observations upon the periodical phenomena of animal and vegetable life, &c., were established at over 50 stations in the canton, whose elevations were ascertained. These observations, both instrumental and phœnological, have been continued since 1869 without change, the former being published monthly and the latter annually. Those relating to temperature, moisture, and rain-fall, are of most interest in our present inquiries, and in the absence of published generalizations, we have calculated from the monthly reports of eight years[1] (1869 to 1876 inclusive), the following mean results:

I—*Mean temperature of the air at breast height and in the tree tops.* (*Centigrade*).

Months.	Place of observation.	1. Interlaken (larch).			2. Berne (red fir).			3. Pruntrut (beech).		
		Mean of 8 years.	Highest monthly mean in 8 years.	Lowest monthly mean in 8 years.	Mean of 8 years.	Highest monthly mean in 8 years.	Lowest monthly mean in 8 years.	Mean of 8 years.	Highest monthly mean in 8 years.	Lowest monthly mean in 8 years.
January ...	Fields	— 0.17	1.93[5]	— 3.46[3]	— 1.51	0.74[5]	— 5.34[3]	0.31	3.33[7]	— 4.59[3]
	Woods.......	— 0.31	2.10[5]	— 3.85[3]	— 1.57	0.93[5]	— 5.21[3]	0.23	3.28[5]	— 4.43[3]
	Tree tops	— 0.32	2.06[5]	— 4.09[3]	— 2.12	0.62[7]	— 6.20[3]	0.64	3.62[5]	— 3.99[3]
February ..	Fields	2.15	5.44[1]	— 1.05[7]	0.92	5.52[1]	— 2.76[7]	1.96	6.38[1]	— 2.69[7]
	Woods.......	1.74	5.49[1]	— 1.59[7]	0.54	4.68[1]	— 3.30[7]	1.65	6.28[1]	— 2.82[7]
	Tree tops.	2.07	6.04[1]	— 1.52[7]	— 0.16	4.87[1]	— 3.55[7]	2.04	6.72[1]	— 2.48[7]
March	Fields	5 49	8.12[5]	1.95[1]	4.52	7.47[5]	0.63[1]	4.45	7.35[5]	0.35[1]
	Woods	4.93	7.8 [5]	1.36[1]	3.74	6.73[5]	0.16[1]	4.17	6.93[5]	0.13[1]
	Tree tops.	5.49	8.39[5]	1.43[1]	3.32	6.01[5]	0.35[1]	4.51	7.46[5]	0.72[1]
April	Fields	10.92	12.64[1]	8.46[5]	10.51	10.71[1]	8.26[5]	10.11	12.05[1]	7.33[5]
	Woods.......	10.31	11.79[1]	8.01[5]	9.45	11.04[1]	7.52[5]	9.95	11.84[1]	7.13[5]
	Tree tops	10.51	12.32[1]	8.16[5]	9.24	12.05[1]	6.82[5]	10.81	12.62[1]	7.36[5]
May	Fields	13.99	17.26[7]	11.25[6]	13.73	16.96[7]	10.98[6]	12.92	16.23[7]	10.19[6]
	Woods.... ..	13.10	15.85[7]	9.98[6]	12.72	15.58[7]	9.80[6]	12.05	14.75[7]	9.16[6]
	Tree tops.	12.96	16.22[7]	7.94[6]	12.53	15.54[7]	9.65[6]	12.59	15.51[2]	9.60[6]
June	Fields	17.34	19.02[2]	14.64[3]	17.23	19.13[3]	14.25[3]	16.55	18.77[2]	13.60[3]
	Woods......	15.93	18.00[2]	13.29[3]	16.07	18.45[2]	13.43[3]	15.05	17.46[2]	12.29[3]
	Tree tops	16.17	18.32[2]	13.49[3]	15.81	17.92[3]	12.76[3]	15.75	18.07[2]	13.09[3]
July	Fields	20.86	22.34[1]	18.40[7]	21.04	22.40[1]	17.98[7]	20.55	21.60[1]	17.42[7]
	Woods.......	19.28	21.01[1]	16.52[7]	19.62	21.11[1]	16.43[7]	18.91	19.62[1]	15.54[7]
	Tree tops.	19.64	21.23[1]	16.79[7]	19.55	21.33[1]	16.26[7]	19.65	20.70[1]	15.88[7]
August	Fields	18.82	21.05[7]	16.05[2]	18.87	21.07[5]	16.29[2]	18.53	20.66[5]	16.38[2]
	Woods.......	17.22	19.03[7]	15.35[2]	17.73	19.27[5]	15.54[2]	16.98	19.19[5]	15.07[2]
	Tree tops	17.66	19.63[7]	15.57[2]	17.42	19.35[5]	14.95[2]	17.51	19.97[5]	15.68[2]
September.	Fields	16.61	18.25[6]	14.54[2]	16.27	17.91[3]	14.12[2]	16.16	18.09[3]	13.95[8]
	Woods.......	15.17	16.74[3]	13.14[8]	14.86	17.09[3]	12.80[3]	14.62	16.83[3]	12.50[8]
	Tree tops	15.76	17.64[3]	13.37[8]	14.70	16.44[3]	12.54[2]	15.21	17.77[3]	12.63[8]
October....	Fields	10.24	13.07[8]	8.41[1]	9.43	12.19[8]	7.18[3]	9.78	12.28[8]	7.46[1]
	Woods.......	9.41	11.98[8]	7.70[1]	8.58	11.07[8]	6.60[1]	8.97	11.18[8]	6.73[1]
	Tree tops	9.78	12.29[8]	8.00[1]	8.17	10.86[8]	6.07[3]	9.13	11.19[8]	7.03[7]
November.	Fields	3.64	5.76[4]	1.60[3]	2.86	5.77[4]	— 0.22[3]	3.45	6.87[4]	— 0.53[3]
	Woods.......	3.21	5.68[4]	1.23[3]	2.62	5.43[4]	0.08[3]	3.03	6.62[4]	— 0.59[3]
	Tree tops	3.35	6.00[4]	1.57[3]	2.43	4.68[4]	— 0.78[3]	3.34	6.85[4]	— 0.39[3]
December .	Fields	— 0.78	3.37[8]	— 5.00[3]	— 2.36	2.41[8]	— 7.53[3]	— 1.01	4.77[8]	— 4.98[2]
	Woods.......	— 0.88	3.37[8]	— 5.05[3]	— 2.28	2.18[8]	— 7.43[3]	— 0.83	4.37[8]	— 4.81[2]
	Tree tops.	— 0.92	3.16[4]	— 4.93[3]	— 2.81	2.02[8]	— 8.56[3]	— 0.29	4.53[8]	— 4.19[2]
Year...	Fields	9.92	10.50[5]	9.30[2]	9.23	10.00[5]	8.50[2]	9.51	10.21[5]	8.53[2]
	Woods.......	9.12	9.68[5]	8.44[2]	8.54	9.34[5]	7.94[2]	8.70	9.41[5]	7.91[2]
	Tree tops.	9.38	10.01[5]	8.86[2]	8.09	8.95[5]	7.28[2]	9.23	9.90[5]	8.53[2]

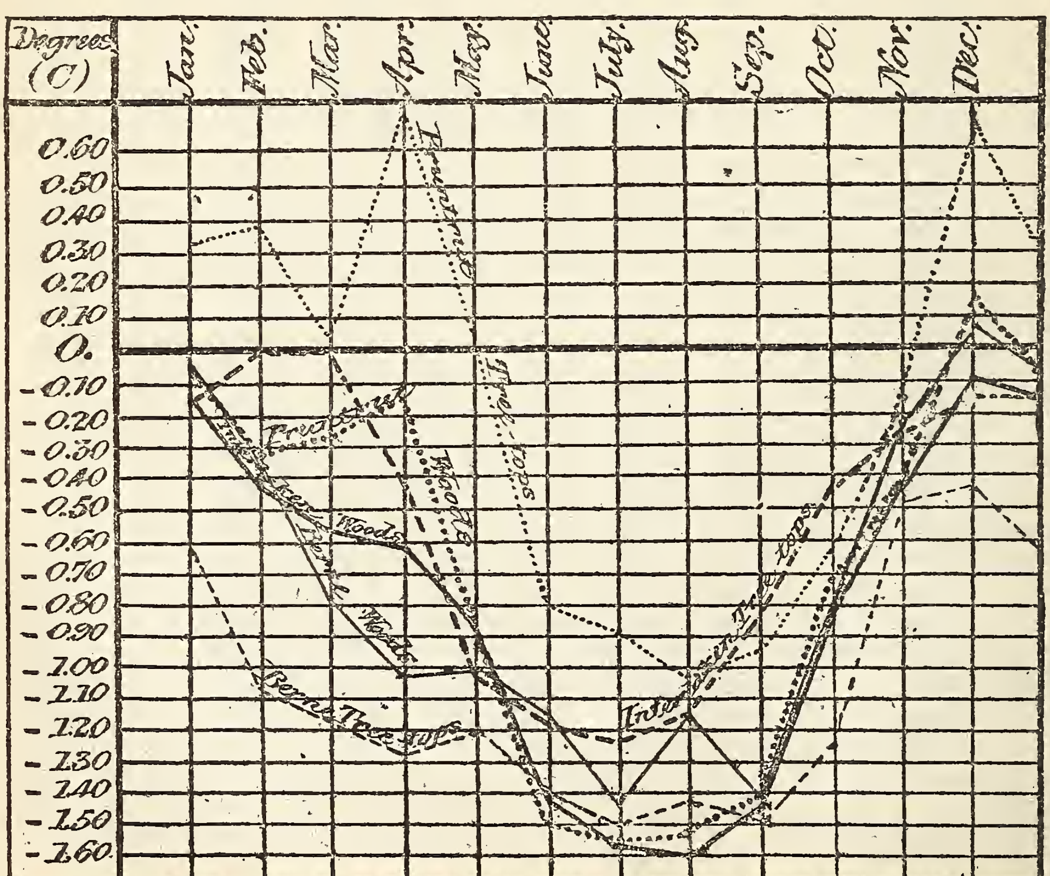
[1] 1869. [2] 1870. [3] 1871. [4] 1872. [5] 1873. [6] 1874. [7] 1875. [8] 1876.

[1] The returns for November, 1870, are wanting, and the results for that month accordingly embrace but seven years.

II.—*Comparison of mean results of foregoing table.*

Months.	1. Interlaken (larch).		2. Berne (red fir).		3. Pruntrut (beech).	
	Woods.	Tree tops.	Woods.	Tree tops.	Woods.	Tree tops
January	−0. 14	−0. 15	−0. 06	−0. 61	−0. 08	+0. 33
February	−0. 41	−0. 08	−0. 38	−1. 08	−0. 31	+0. 39
March	−0. 56	0. 00	−0. 78	−1. 19	−0. 28	+0 06
April	−0. 61	−0. 41	−1. 02	−1. 27	−0. 16	+0. 69
May	−0. 89	−1. 03	−1. 01	−1. 20	−0. 87	+0. 06
June	−1. 41	−1. 17	−1. 16	−1. 42	−1. 50	−0. 80
July	−1. 58	−1. 22	−1. 42	−1. 49	−1. 54	−0. 99
August	−1. 60	−1. 16	−1. 14	−1. 45	−1. 55	−1. 02
September	−1. 44	−0. 85	−1. 41	−1. 57	−1. 44	−0. 95
October	−0. 83	−0. 46	−0. 85	−1. 26	−0. 81	−0. 65
November	−0. 43	−0. 29	−0. 24	−0. 43	−0. 42	−0. 11
December	−0. 10	−0. 14	+0. 08	−0. 45	+0. 18	+0. 72
Year	−0. 80	−0. 54	−0. 74	−1. 19	−0. 81	−0. 28

It appears from an examination of this table, that except in the winter months the mean temperature of the woods is uniformly less than in the fields, and that it is in most cases in summer cooler near the ground of a forest than in the tree tops. The greatest difference was observed in July, except in the fir forest of Berne, where the difference was most in April, both near the ground and at the tree tops. The greatest symmetry of curves (when these quantities are drawn upon a diagram) occurs in the beech forest. In all cases December is warmer near the ground of a forest than in the fields, and here but little difference occurs between trees of different kinds. A great and sudden decrease of differences in September and October is observed in all cases.



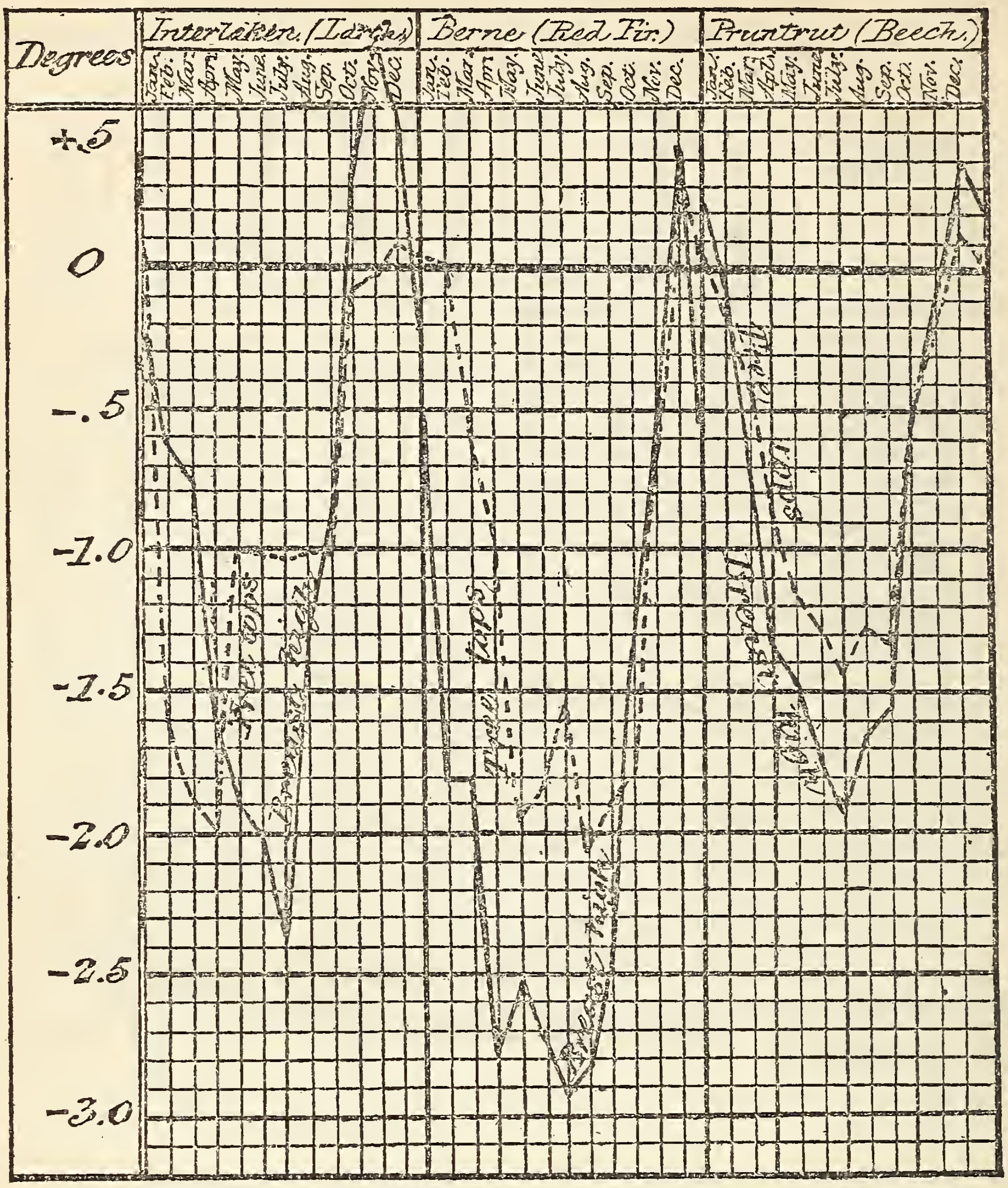
Degrees above or below the mean of open fields, at three Swiss stations.

III.—*Mean temperature of the trees, above or below the mean temperature of the air in the woods, at the place of observation.*[1] (Centigrade).

Months.	Place of observation.	1. Interlaken (larch).			2. Berne (red fir).			3. Pruntrut (beech).		
		Mean of 8 years.	Highest monthly mean in 8 years.	Lowest monthly mean in 8 years.	Mean of 8 years.	Highest monthly mean in 8 years.	Lowest monthly mean in 8 years.	Mean of 8 years.	Highest monthly mean in 8 years.	Lowest monthly mean in 8 years.
January ...	Breast high..	−0.22	+0.70	−1.42	−0.51	+0.22	−0.92	+0.22	+1.01	−2.01
	Tree tops ...	+0.10	+0.53	−0.40	+0.10	+0.74	−0.13	−0.03	+0.83	−0.63
February ..	Breast high..	−0.61	+0.97	−1.87	−1.78	−0.76	−4.08	−0.08	+3.97	−1.19
	Tree tops .	−1.63	+0.24	−7.24	−0.58	+0.09	−0.95	−0.15	+0.53	−1.25
March	Breast high..	−0.77	−0.07	−1.50	−1.78	0.00	−2.52	−0.72	+0.34	−1.34
	Tree tops ..	−1.79	−0.19	−7.90	−0.96	−0.15	−1.71	−0.44	+0.67	−1.29
April	Breast high..	−1.57	−0.79	−2.15	−2.82	−2.14	−3.79	−1.31	−0.23	−1.97
	Tree tops...	−2.05	−0.41	−7.32	−1.90	−0.95	−2.53	−0.82	0.00	−1.42
May	Breast high..	−1.91	−1.13	−3.28	−2.51	−1.35	−3.71	−1.47	−0.82	−2.20
	Tree tops ..	−1.01	+1.03	−2.75	−1.81	−1.28	−2.54	−1.16	−0.60	−1.89
June.......	Breast high..	−2.02	−1.29	−2.66	−2.73	−2.21	−3.59	−1.75	−1.29	−2.26
	Tree tops....	−1.15	−0.81	−1.52	−1.57	−0.25	−2.24	−1.27	−0.74	−1.55
July.......	Breast high..	−2.36	−1.29	−2.75	−2.92	−2.28	−3.34	−1.91	−0.64	−2.33
	Tree tops ...	−1.24	−0.71	−1.71	−2.07	−1.21	−3.08	−1.42	−0.88	−1.83
August....	Breast high..	−1.30	−0.65	−2.06	−2.82	−1.80	−4.34	−1.66	−0.95	−1.97
	Tree tops ...	−0.98	−0.49	−1.55	−1.85	−1.53	−2.59	−1.28	−1.08	−1.61
September.	Breast high..	−0.85	−0.21	−1.07	−2.46	−1.91	−3.14	−1.55	−0.99	−1.63
	Tree tops....	−1.06	−0.56	−1.90	−1.79	−1.00	−2.72	−1.31	−0.63	−1.66
October....	Breast high..	+0.31	+0.87	−0.36	−1.34	−0.14	−1.81	−0.52	+0.13	−0.87
	Tree tops ...	−0.80	−0.24	−3.63	−0.73	−0.39	−1.10	−0.65	−0.19	−1.14
November .	Breast high..	+1.82	+1.15	−0.61	−4.42	+0.40	−1.26	−0.92	+0.93	−0.66
	Tree tops ..	−6.01	+0.45	−6.94	−1.61	+0.26	−1.05	−1.22	+0.42	−0.65
December	Breast high..	+0.54	+1.52	−0.32	+0.44	+3.11	−0.88	+0.39	+3.63	−2.30
	Tree tops....	−0.37	+1.13	−6.68	+0.73	+3.24	−1.76	+0.13	+1.50	−1.19
Year.......	Breast high..	−0.92	−0.77	−1.14	−1.93	−1.80	−2.11	−1.10	−0.55	−2.39
	Tree tops....	−1.01	−0.43	−3.39	−0.89	−0.12	−1.88	−0.69	−0.27	−0.94

[1] In preparing this table we have taken the difference of the temperature within the trees at breast high and that of the open air at the same height. The temperatures in the tree tops, within and without the tree, are also shown.

The facts shown in the preceding table, when reduced to graphic representation, appear as follows:



Mean temperature of the trees above or below the mean temperature of the air.

In these results we observe a greater regularity and less differences in the beech than in either of the coniferous species, apparently due to differences in their conductors of heat, rather than an external cause. It does not appear but that the exposures were alike and that the external conditions were essentially the same.

IV.—*Difference of mean temperature of the soil in the woods above or below that at similar depths in the open fields.* (Centigrade).

Months.	Stations.	Depth of soil at which temperatures were observed. Surface.	0.3 meter (11.81 inches.)	0.6 meter (23.62 inches.)	0.9 meter (35.43 inches.)	1.2 meter (47.24 inches.)
January	Interlaken (larch)	+0. 03	+0. 74	+0. 65	+0. 63	+0. 26
	Berne (red fir)	—0. 03	+0. 44	+0. 37	+0. 08	+0. 01
	Pruntrut (beech)	+0. 27	+0. 02	0. 00	+0. 21	—0. 20
February	Interlaken (larch)	—0. 56	+0. 72	+0. 79	+0. 78	+0. 48
	Berne (red fir)	—0. 46	—0. 07	—0. 12	—0. 07	—0. 08
	Pruntrut (beech)	—0. 53	—0. 03	+0. 05	+0. 13	+0. 08
March	Interlaken (larch)	—2. 10	—0. 51	+0. 15	+0. 18	+0. 35
	Berne (red fir)	—3. 01	—2. 62	—2. 18	—1. 92	—1. 67
	Pruntrut (beech)	—1. 39	—0. 68	—0. 44	—0. 23	—0. 46
April	Interlaken (larch)	—2. 90	—1. 45	—0. 53	—0. 33	—0. 41
	Berne (red fir)	—4. 27	—3. 91	—3. 98	—3. 93	—3. 27
	Pruntrut (beech)	—1. 79	—1. 05	—0. 74	—0. 85	—0. 81
May	Interlaken (larch)	—3. 79	—2. 24	—1. 19	—0. 92	—0. 77
	Berne (red fir)	—4. 05	—4. 53	—4. 78	—4. 86	—3. 88
	Pruntrut (beech)	—4. 50	—2. 16	—1. 70	—1. 85	—1, 59
June	Interlaken (larch)	—4. 56	—3. 03	—1. 92	—1. 78	—1. 63
	Berne (red fir)	—4. 37	—4. 88	—5. 43	—5. 76	—5. 17
	Pruntrut (beech)	—5. 30	—3. 13	—2. 29	—3. 02	—2. 59
July	Interlaken (larch)	—4. 80	—3. 31	—2. 01	—2. 20	—1. 93
	Berne (red fir)	—4. 56	—5. 18	—6. 00	—6. 38	—5. 80
	Pruntrut (beech)	—5. 73	—3. 59	—3. 22	—3. 76	—3. 16
August	Interlaken (larch)	—3. 82	—2. 79	—2. 16	—2. 13	—2. 02
	Berne (red fir)	—4. 08	—4. 54	—5. 19	—5. 76	—5. 33
	Pruntrut (beech)	—4. 72	—3. 03	—2. 92	—3. 46	—2. 82
September	Interlaken (larch)	—3. 57	—2. 28	—1. 90	—1. 89	—1. 59
	Berne (red fir)	—3. 45	—3. 53	—4. 09	—4. 73	—4. 49
	Pruntrut beech)	—3. 78	—2. 23	—2. 22	—2. 65	—2. 51
October	Interlaken (larch)	—1. 60	—1. 41	—1. 21	—1. 27	—1. 47
	Berne (red fir)	—1. 40	—2. 19	—2. 36	—2. 90	—3. 03
	Pruntrut (beech)	—1. 68	—1. 20	—1. 32	—1. 64	—1. 74
November	Interlaken (larch)	—0. 27	—0. 24	—0. 18	+0. 73	—0. 76
	Berne (red fir)	—0. 38	—0. 56	—0. 59	—0. 94	—1. 23
	Pruntrut (beech)	—0. 23	—0. 32	—0. 67	—0. 69	—1. 01
December	Interlaken (larch)	—0. 09	+0. 40	+0. 42	—0. 30	+0. 16
	Berne (red fir)	+0. 26	+0. 31	+0. 31	—0. 04	—0. 19
	Pruntrut (beech)	+0. 46	+0. 08	—0. 14	—0. 08	—0. 40
Year	Interlaken (larch)	—2. 21	—1. 26	—0. 84	—0. 76	—0. 93
	Berne (red fir)	—2. 39	—2. 54	—3. 55	—3. 11	—2. 96
	Pruntrut (beech)	—2. 40	—1. 46	—1. 32	—1. 48	—1. 54

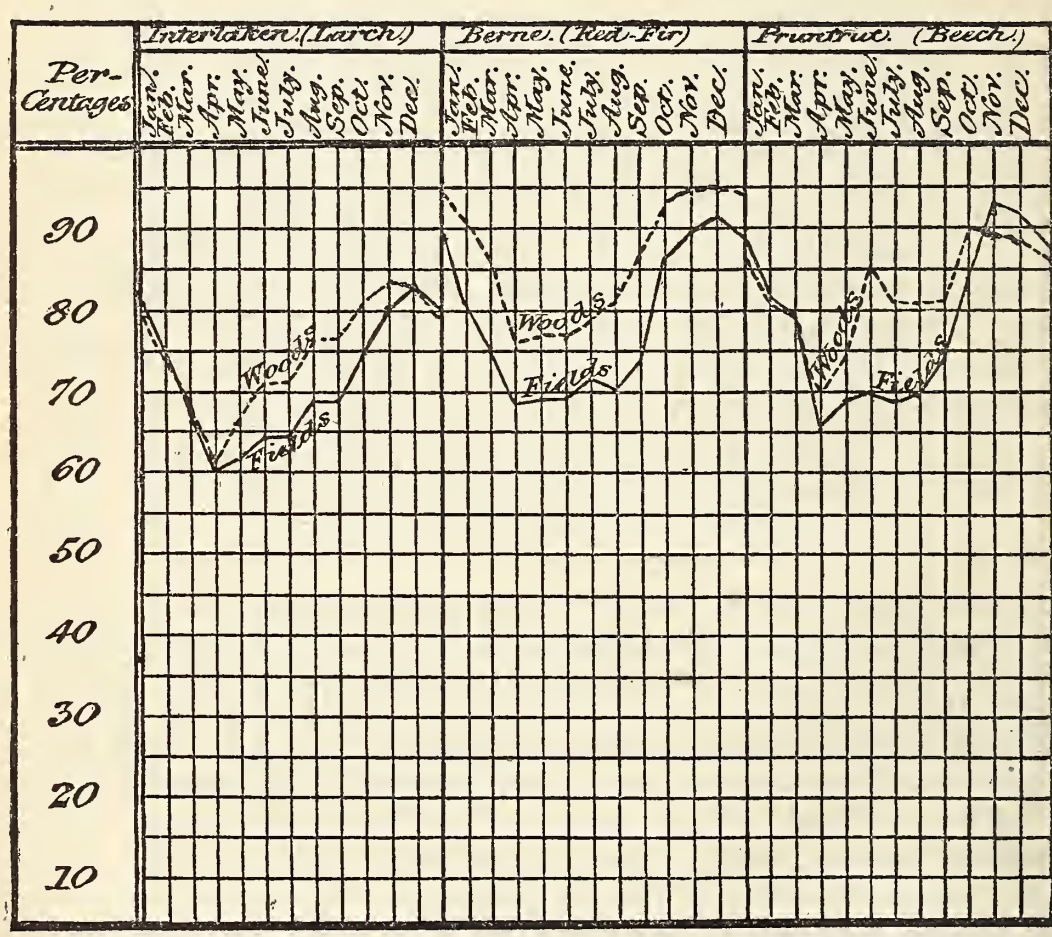
Upon comparing the numbers in this table it will be seen, that in the winter months the soil of the open fields is almost invariably colder than in the woods; but that in summer, the difference is very considerably changed, the soil of the woods at all depths, and with all kinds of timbers observed, being much cooler than that in the fields. The difference at the first and third stations was much greater at the surface, and diminished with the depth. This range of difference is almost invariably greatest in August, and it disappears very rapidly in the autumnal months. As in the case of the temperatures of the open air, the difference increases and diminishes more regularly with the beech than with either the larch or the fir. In all cases, with but a single exception, the difference increases steadily to its maximum, and then again declines. The exceptional instance is that of the surface temperature at the Berne station, where the mean of eight years gives a difference of 4.27 in April, 4.05 in May, and 4.56 in June.

V.—*Mean percentage of moisture in the atmosphere.*

(0 = absolute dryness; 100 = saturation.)

Months.	Interlaken (larch).			Berne (red fir).			Pruntrut (beech).		
	Fields.	Woods.	Difference.	Fields.	Woods.	Difference.	Fields.	Woods.	Difference.
January	81.51	79.28	— 2.23	89.67	94.33	4.66	88.88	86.51	— 2.37
February	75.07	74.47	— 0.60	81.87	91.93	10.06	82.41	82.56	0.15
March	68.63	69.11	0.48	75.19	86.15	10.96	79.55	79.65	0.10
April	60.84	62.91	2.07	68.32	77.00	8.68	66.10	70.23	4.13
May	62.70	67.79	5.09	69.47	78.40	8.93	68.86	74.42	5.56
June	64.67	71.68	7.01	69.17	78.52	9.35	70.35	85.39	15.04
July	64.77	72.62	7.85	72.12	79.42	7.30	69.08	81.31	12.23
August	68.24	76.98	8.74	70.44	82.95	12.51	70.96	81.10	10.14
September	68.58	77.35	8.77	74.14	87.23	13.09	74.15	81.90	7.75
October	75.39	81.29	5.90	86.72	93.91	7.19	83.65	89.25	5.60
November	80.40	82.55	2.15	90.30	94.03	3.73	91.40	89.62	— 1.78
December	83.56	83.33	— 0.23	92.68	95.78	3.10	92.02	88.70	— 3.32
Year	71.19	74.95	3.76	78.34	85.80	7.46	78.12	81.55	3.43

These quantities may be represented to the eye as follows:

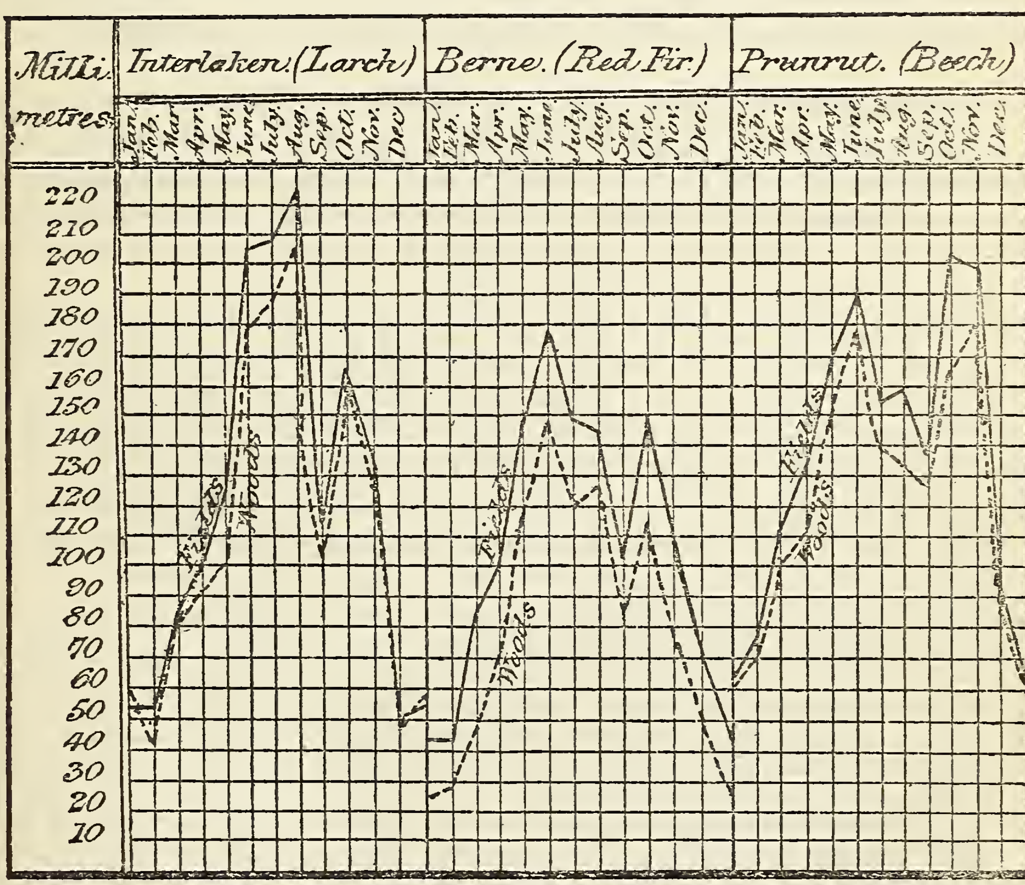


Mean percentage of moisture in the atmosphere of the open fields and of the woods, in the different months of the year.

The excess of moisture in the atmosphere of woodlands in summer, and in evergreen forests at all seasons, is made quite apparent from this table and the graphic illustration that accompanies it. The difference observed in the fir-forest in winter would be more probably due to the obstruction offered by the winds than to any effect due to organic life, as might occur at a season of active growth when evaporation would supply some excess of moisture to the air.

VI.—*Mean depth of rain and melted snow.* (Millimeters).

Months.	Interlaken (larch).			Berne (red-fir).			Pruntrut (beech).		
	Fields.	Woods.	Difference.	Fields.	Woods.	Difference.	Fields.	Woods.	Difference.
January	54.3	58.3	— 4.0	43.9	25.6	18.3	66.0	60.5	5.5
February	54.3	42.8	11.5	43.8	27.5	16.3	77.8	70.3	7.5
March	85.3	83.4	1.9	83.0	49.5	33.5	111.0	101.7	9.3
April	101.7	91.4	10.3	10[illegible].4	71.3	29.1	132.4	112.8	19.6
May	125.7	101.9	24.8	148.4	119.5	28.9	170.3	149.2	21.1
June	204.3	180.2	24.1	179.0	147.7	31.3	190.4	178.7	11.7
July	208.3	186.8	21.5	149.0	120.1	28.9	155.0	140.9	12.5
August	22[illegible].9	205.6	19.3	146.6	125.5	21.1	159.6	133.9	15.7
September	113.8	102.1	11.7	103.9	82.3	21.6	138.2	128.9	9.3
October	164.4	161.3	3.1	149.5	115.3	34.2	193.4	166.7	26.7
November	133.2	126.0	7.2	109.2	74.8	34.4	199.1	179.7	19.4
December	51.3	47.8	3.5	71.9	49.0	22.9	96.7	85.3	11.4
Year	1,521.5	1,387.6	133.9	1,328.6	1,008.1	320.5	1,689.9	1,508.6	181.3



Mean depth of rain and melted snow in open fields and in woods, in different months of the year.

The effect of foliage in intercepting a part of the rains, more especially in summer (in deciduous forests), becomes quite apparent, when the numerical quantities are drawn upon a diagram. Here again we observe the perennial effect of evergreen foliage, in which the *difference between different seasons* in a fir-forest is quite small as compared with either of the deciduous kinds represented, and the *total amount* of this difference is at all times greater.

FRANCE.

In April, 1866, meteorological observations were commenced by Professor Mathieu, of Nancy, at two forest stations and at an agricultural station, with the view of determining facts concerning evaporation, rainfall, &c., and the influence which a wooded or unwooded country has upon the moisture received from the air.[1]

In an article published in 1874, eight years after these observations were commenced,[2] Professor Mathieu remarks that the results completely confirm those made at Asschaffenburg:

> These observations have shown, as to that station, that the mean temperature of the air at 1.5 meters above the soil is at all seasons, and especially in summer, lower within the woods than in the fields, and consequently that the mean annual temperature of the air in forests is below that of the open country. The difference, however, is not large, and in 1872 did not exceed 0°.51 of the centigrade scale. At Asschaffenburg, the results of several years' observation make the difference 0°.78.

The results of evaporation are not less remarkably coincident. The French report of evaporation from an open surface of water, within and without the woods, in 1872, showed the proportion as 37 per cent.—the German station as 36. The evaporation from a free water surface is the same as from a surface of native soil saturated. A covering of dead leaves has the same protecting influence on the soil as dense growth of trees.

The results near Nancy still further agree in showing, that woodlands exert a much greater influence upon the evaporation than upon the temperature of the air and the soil, which leads to the conclusion that evaporation and humidity are greatly influenced by the greater or less agitation of the air. Hence the importance of a covering of leaves, and of screens to check the action of the winds.

It is further noticed that a wooded country tends to increase the precipitation of atmospheric moisture, most sensibly in sloping and mountainous regions, and that on plains this effect is scarcely appreciable; and, furthermore, that about 26 per cent. of the rain is intercepted by the foliage of the trees. The amount differs much between forests of different kinds, and in beech 60 years old it was found to be but 17 per cent. Here again the observations at Nancy confirm the principle, although

---

[1] The stations were located as follows:

Cinq-Tranches; on a plateau 380 meters above sea-level, in the midst of the vast forest of *La Haye*, which crosses the chain of Jurassic hills of lower oölite traversing the department of Meurthe from north to south. Two udometers were placed to measure the amount of water that fell under the different conditions there found. The first was placed in a forest (lightly cleared) of hornbeam and beech 41 years old, and consisted of a receiver through which passed the trunk of a tree of average size, and with a surface equal to that covered by the tree-top. It showed exactly the depth of water which reached the ground, either from the leaves or their intervals, or from the trunk, with whatever irregularity it might be sifted by the covering. The other udometer was placed about 200 meters from the former, in the middle of a cleared place several hectares in extent, and at a distance from every object that could hinder or modify the rain-fall. It was of the ordinary construction.

Belle-Fontaine; 240 meters above sea-level, at the bottom of a valley open from southeast to northwest, on the border of the forest plateau of La Haye, at only 2 kilometers from Meurthe. The woods are like those of the former station, 71 years old. Two instruments for measuring the evaporation were placed here, exactly comparable as to size and mode of construction, and 300 meters apart; one in the open fields, and the other in the woods. Rain-gauges were also placed, of the usual form. The evaporating basins were filled to an equal depth, and at the end of a month were measured to determine the changes, deductions being made for rain-fall.

Amance, an agricultural station; 16 kilometers east of Cinq-Tranches, and of equal altitude, remote from forests of any notable size. Its rain-gauge was of the usual form.

[2] *Revue des Eaux et Forêts*, May, 1874, p. 165. See also the *Atlas Météorologique* of the Observatory of Paris, where the annual results are published.

from differences of forests the amount of rain was reduced but 12 to 13 per cent.

Observations for determining the effect of woodlands upon the climate are also made at the experimental station and School of Forest Guards at Barres, the results being reported to the general office of the service, and to the observatory at Mount-souris.

Observations upon the rain-fall made under the direction of the Marshal Vaillant.

In 1866, two series of observations were made upon eight rain-gauges in the Crown forests of Fontainebleau and Gonards, with the view of determining the influence of a covering of woodland upon the amount of rain reaching the earth. There were four gauges at each place, of which one was exposed freely to the open air, and the remaining three under woods of different kinds. These observations were published in the *Revue des Eaux et Forêts*, and in the *Atlas Météorologique* of the Imperial Observatory of Paris for 1867. Instead of giving the *actual* rain-fall in the woods we give the *difference* between this and the amount falling in an open space, as this element is the one of chief importance in these studies:

Rainfall in open fields and in woods. (Millimeters.)

Months.	Forest of Fontainebleau.				Forest of Gonards, near Versailles.			
		In woodland.				In woodland.		
	In open air (depth).	Under *Pinus sylvestris*, 35 years old (difference).	Under leaf-woods, 35 years old (difference).	Under spruce, 35 years old (difference).	In open air (depth).	Under oaks, 75 to 120 years old (difference).	Under leaf-woods, 23 years old (difference).	Under *Pinus sylvestris*, 35 years old (difference).
January	0. 0350	—. 0152	—. 0105	—. 0295	....	....	....	....
February	0. 0785	—. 0367	—. 0055	—. 0557	0. 0227*	+. 0023	+. 0013	—. 0085
March	0. 0808	—. 0333	—. 0226	—. 0660	0. 0410	—. 0050	—. 0030	—. 0225
April	0. 0670	—. 0230	—. 0170	—. 0305	0. 0655	—. 0035	—. 0045	—. 0355
May	0. 0462	—. 0150	—. 0147	—. 0347	0. 0550	—. 0020	—. 0105	—. 0238
June	0. 0660	—. 0232	—. 0340	—. 0532	0. 0305	—. 0080	—. 0070	—. 0157
July	0. 1078	—. 0383	—. 0620	—. 0690	0. 0528	—. 0170	—. 0138	—. 0248
August	0. 1170	—. 0455	—. 0570	—. 0920	0. 0895	—. 0180	—. 0220	—. 0367
September	0. 1235	—. 0353	—. 0585	—. 0840	0. 0775	—. 0083	—. 0180	—. 0335
October	0. 0310	—. 0130	—. 0168	—. 0275	0. 0238	—. 00[illegible]3	—. 0058	—. 0113
November	0. 0475	—. 0213	—. 0185	—. 0387	0. 0278	—. 0040	—. 0098	—. 0136
December	0. 0612	—. 0470	—. 0177	—. 0512	0. 0762	—. 0360	—. 0412	—. 0512
General result	0. 8595	—. 3468	—. 3348	—. 6320	0. 5623	—. 1028	—. 1343	—. 2771

* The rain-gauge at Gonards was not established until February 23. The marshal expressed an intention of establishing two other sets of observations, but we are not aware that this was done.

Comparative observations of M. Fautrat.

This observer has communicated on several occasions to the Academy of Sciences at Paris, the results of comparative observations made by him at stations 8 kilometers apart, and as follows:

Deciduous forest of Hallette, France, 108 meters above tide.
Scotch-pine forest of Ermenonville, 92 meters above tide.

So far as we have met with these records they extend, when combined, over a period from June, 1875, to October, 1877, giving in all two entire

years, and a part of a third year, from June to October inclusive. The means by months combined for this period give the following results at 1.4 meters above the ground:

Mean differences of temperature between open fields and woods. (Centigrade.)

Months.	Leaf-woods.	Pine-woods.	Mean of pine above or below leaf woods.	Months.	Leaf-woods.	Pine-woods.	Mean of pine above or below leaf woods.
January	+0. 30	—0. 17	—0. 47	July	—0. 83	—1. 27	—0. 44
February	—0. 10	—0. 90	—0. 80	August	—0. 77	—1. 43	—0. 66
March	0. 00	—0. 75	—0. 75	September	—0. 77	—1. 30	—0. 53
April	+0. 15	—1. 00	—1. 15	October	—0. 20	—0. 90	—0. 70
May	—0. 10	—1. 05	—0. 95	November	—0. 50	—0. 45	+0. 05
June	—0. 67	—0. 83	—0. 16	December	—0. 25	—0. 40	+0. 15

It would appear from this, that pine-woods have generally greater effect in cooling the air near the surface than leaf-woods, but these observations have not been continued long enough to enable us to arrive at any very definite results.

SWEDEN.

During the two years, the Swedish Government has ordered the establishment of scientific stations at Upland, in Scania, in the southeastern part, and at Skasaborg, with the view of studying the influence which forests exert upon the surrounding country, by registering climatological and meteorological observations. We have seen no results of these observations.

There are understood to be comparative observations going on at other places in Europe, but we are unable to state particulars.

THE PASSAGE OF STORM-AREAS OVER FORESTS.

With respect to storms, it is now quite well established, that they are coincident with areas of low barometric pressure, which are often many hundred miles across, and when oval, usually longer from north to south. These low-areas generally move eastward in north latitudes, and upon an average of thirty miles an hour. The air itself does not travel with them, any more than the waters of the ocean in tides. There is an inward tendency of the winds towards an area of low barometer, and were it not for the earth's motion, these might be towards a central point; but in fact, their course is more or less oblique, generally from 30° to 60° from a radial line, and in northern latitudes always toward the right.

These areas of low barometer are not always stormy, and over a wide arid region might not be cloudy. But they are generally attended with cloudy weather, and when the conditions are favorable, with rain. These circumstances depend upon the relative humidity of the atmosphere, and as this varies, the width of cloudy or rainy area is constantly changing. With respect to the degree of saturation of the atmosphere, it is found to increase from below upward, to the level where clouds form, and to diminish above this, to the highest limit of the clouds. There is reason to believe that the higher regions of the atmosphere are

dry, except as upward currents may carry moist air from below, and that rain-falls are mostly derived from low clouds that have derived their moisture from the earth near by[1]. It is accordingly found, that the rain-fall may increase or diminish in amount, as these storm-areas move along over moist or dry regions. With respect to these effects, the statement is made[2] that "the rapidity of movement is a physical question that cannot yet be solved numerically, but, in general, it is known that for the same temperature, the moister the air or the greater its relative humidity, the greater will be the effect of a general diminution of pressure or temperature in inducing condensation and a further fall of the barometer."

From these facts it follows, that as extensive areas of woodland, over which the air is relatively more humid than over open fields, present the conditions most needed for the precipitation of rain, upon the passage of areas of low barometric pressure, their presence tends to diminish this pressure and the temperature, both of which imply the further formation of rain. "Wherever the moister air exists, there the condensation will take place the more rapidly, there the barometer will also fall the most rapidly, and thither the storm will be strongest driven. Great storms naturally, therefore, move more rapidly up towards the lakes, and hang tenaciously over them, and move slowly away from them."[3] It is found that the lowest barometer, in a passing storm-area, is felt after the rain has begun to fall, and that "the presence of a surface area of dry air is oftentimes sufficient to dissipate these storms, or to cause them to retire into the cloud-regions."

DESIGNATIONS OF CLIMATE:—INCLINATIONS OF SURFACE.

It is convenient to have a definition of degrees, in speaking of the character of a climate in its reference to sylviculture, and to this end the following terms are specified, by an approved writer upon forestry:[4]

Warm climates are those in which the olive, the fig, and cork tree will grow spontaneously.

Mild climates produce the vine, the almond, and the peach in the open air, with full success, as also all kinds of fruit-trees and culinary vegetables. Acorns and beech-nuts grow in great abundance every two or three years.

In temperate climates fruit-trees and garden vegetables generally thrive well. In the forest we see all forest trees growing, except such as are limited to warm climates. Acorns and beech-nuts abound once in six or eight years.

In rude climates the culture of fruit trees and delicate garden vegetables is difficult. In the forest, resinous trees more abound, and years of fruitful growth of acorns, &c., are rare.

In very rude climates buckwheat, oats, and potatoes are the principal harvests that come to maturity. The prevaling kinds of timber are the firs, the larch, the birch, and the beech, but the latter is almost always poorly developed. In plains, these designations sufficiently characterize the general climate, as respects forests, and we shall but rarely have occasion to mention exceptions of temperature in certain districts. Upon mountains, however, everything depends upon elevation and exposure, on account of the modifications which they produce, and we may pass through every degree in rising a few thousand feet.

---

[1] Circular of Signal Office, War Department, entitled *Practical use of Meteorological Reports and Weather Maps*, p. 25.

[2] *Ib.*, p. 36.

[3] *Ib.*, p. 32.

[4] *Cours d'Amenagement des Forets, by H. Nanquette* (1860), p. 12.

Writers upon forestry adopt the following as a proper definition of inclined surfaces:

A gentle slope is from level to 10° of elevation.
A somewhat steep slope from 10° to 20°.
A steep slope from 20° to 34°.
A very steep slope from 35° to 45°.
An escarpment 45° and upwards.

As a general rule, the climate of plains is more uniform than that of mountains, but this depends upon elevation, prevailing winds, and proximity to large bodies of water. The latter have an equalizing tendency, and the choicest fruit-regions of the country owe this excellence to the protections thus afforded against premature blossoming.

If such, we have examples in the fruit-belt along the eastern shore of Lake Michigan, the southern shores of Lakes Erie and Ontario, and the region around the southern end of the interior lakes of central and western New York.

The influence of aspect upon the growth of trees, depends something upon the prevailing winds and other causes. But soil, slope, and other conditions being otherwise the same, we may state the effects of aspect approximately as follows:

The northern aspect receives no sun, or but obliquely, according to the angle of elevation. The winds are colder and dryer, and generally in the growing season not strong. The soil retains its moisture, and the growth of vegetation is rapid. The trees retain a more regular shape, and their tissues are softer. The timber is therefore not as strong, but it is very well adapted to manufacturing purposes. The later vegetation on a north slope delays the opening of buds, and reduces the risk from late spring frosts; but from the late hardening of summer growth, some injury may occur from freezing in winter. The snows lie longest on this slope, which very materially favors forest growth. The starting of a forest by seeding is more easily secured on a north slope than any other. It was on a northern slope only, that forest seeds sown upon the damp snows in the works of replanting the mountain regions of the Alps, by the French Government, were found to succeed.

The eastern aspect receives the direct rays of the sun in the cool morning hours, and the temperature and light are moderate. The winds (in the United States) are often damp, especially in winter, and the trees seldom become loaded with ice, except when the eastern winds are blowing. The soil holds its moisture fairly, and the timber grows well, and acquires medium qualities that adapt it to the greatest variety of uses.

The southern aspect receives the direct rays of the sun, and the light and heat are both intense. It is liable to winds and storms, and to erosion from rains, because from the heat, a protecting growth of herbage is less liable to be found on the soil. The trees have, on the whole, a slower growth and less regular form, but the timber is firm, heavy, and strong, well adapted for building and manufacturing purposes. Seeding can seldom be secured on an open exposure to the south in a warm climate, and trees must usually be set and attended with greater care.

On the western slope the sun shines obliquely, but in the hottest hours of the day, and in our Western States, vegetation is most exposed to drying southwesterly winds. The soil is liable to become dry, and tim-

ber is of relatively slower growth and of inferior shape, but the quality in the main is good.

These differences are often but shades that would at times be scarcely observed, especially in isolated hills; but at other times would be strongly marked, especially where a long trend of hills or mountains gave these influences their full effect; and would be most apparent when the slopes in this case are north and south, when the differences amount to contrasts that would attract the notice of a casual observer.

TEMPERATURE.

Although particular species of trees have their limits of endurance and zones of greatest development, determined by the prevailing temperatures, their extremes, succession, and changes, perhaps quite as much as by the humidity of the atmosphere, there are no points within our territory, excepting in Alaska and above the timber-line of our mountains, in which the temperature of itself would forbid the growth of forests.[1] There are vast treeless tracts and arid regions, where trees cannot be made to grow, but this is rather from want of moisture than from any excess or deficiency of heat. In fact, in tropical countries where the greatest heats prevail, there is the greatest luxuriance of forests, where the humidity is abundant.

But the temperatures adverse to one species may be favorable to another, and it is one of the greatest aims of forestry to determine these limits of possibility and zones of best conditions, in order that we may avail ourselves of every chance of success and avoid every risk of failure.

The effects of temperature depend less upon their annual mean degree, or even upon their extremes, if seasonable and not of long continuance, than upon their fluctuation, especially in winter and early spring. The endurance of frosts in plants and trees depends very much upon the state of vegetation, whether in activity or repose. A multitude of herbaceous plants are killed down by frost, at any time during their growing season, but their roots when perennial will endure the severest cold of winter without injury. It is the same with many trees, which are

[1] The "*timber-line*," or limit of forest growth among the Rocky Mountains, is found at an elevation of from eleven to twelve thousand feet above sea-level. The timber rapidly disappears within a vertical range of four or five hundred feet, and the trees along the upper margin of their growth are stinted in height rather than in the size and length of their branches, which are commonly bent extremely in the direction of the prevailing winds. The trunks of trees are often found extremely twisted at these great altitudes, and apparently from the same cause. This is more apparent in places where one side of the tree is quite sheltered by rocks while the other side is much exposed to the winds.

Elevation of the timber-line in the Rocky Mountain region and Pacific States.

[These are mostly from Dr. C. C. Parry's measurements, as published in Professor Hayden's Report of 1872, p. 751.]

	Feet.		Feet.
Bridger's Peak, Montana	9,002	Mount Shasta, California	8,000
Mount Delano, Montana	8,784	Gilbert's Peak in Uintas	11,100
Ward's Peak, Montana	9,156	Long's Peak, Colorado	10,809
Mount Blackmore, Montana	9,550	Audubon's Peak, Colorado	11,325
Second Cañon Madison River, Montana	9,754	Mount Engelmann, Colorado	11,518
Electric Peak, Wyoming	9,442	Berthoud's Pass, Colorado	11,816
Mount near Henry's Lake, Idaho	9,368	Gray's Peak, Colorado	11,643
Mount Washburn, Wyoming	9,900	Pike's Peak, Colorado	12,040
Cascade Range, Oregon	7,000	Colorado in general	11,600 to 12,000
Mount Hayden, Teton Range	11,000	San Francisco Mountain, Arizona	11,547
Wind River Mountains	10,160		

The elevation is less as the latitude increases, and as we approach the sea-coast.

The timber-line in the Himalayas is at 11,800 feet; and on the Alps it averages 6,400, but some trees are found at 7,000 feet above sea-level.

most liable to damage by late spring-frosts, that happen after vegetation has started, or in autumn, before the growth of the young wood has hardened.[1]

Among the questions of greatest practical interest in this inquiry, affecting not only the affairs of sylviculture, but also of agriculture and horticulture in every department, is "To what extent is the temperature of a country affected by the presence of forests, and how is it modified by their removal?" We have already in this report given the results of instrumental observations made at several stations in Europe upon this particular subject. As yet, we have nothing of this kind upon which to base conclusions, and must depend upon opinions and observations of less reliable kind; but still, as coming from men accustomed to close observation, and as based upon facts of undoubted significance, they acquire a certain weight that entitles them to our confidence.[2]

In alleging a change of climate from the cutting off of woodlands, it is not to be expected that a change will continue beyond the degree due to the amount of clearing, and after this is reached we might expect a climate that would continue, on the general average alike, as long as the amount of open country and of woodlands remained relatively the same. Unfortunately, we have no records of rain-fall or of temperature that show these phases of climate as they existed when the country was covered with forest; and the memory of the "oldest inhabitant" is at best fallacious, unless sustained by circumstances which admit of no doubt, as for instance, the freezing of rivers that does not now occur, the culture of fruits now impossible, and facts of this kind which do not simply depend upon opinions.

It will be found that for more than a century the subject of climatic effect from the clearing off of woodlands has engaged the attention of observing persons, and there is good reason to believe that changes due to this cause may have occurred before their day from this cause, because these clearings had been extensive then, and in some cases there have been no important clearings since the time when these observations were recorded.[3]

The occurrence of severe and protracted frosts, in a winter following a dry autumn, has been found to be particularly injurious to trees, and especially to fruit-trees.

---

[1] The spruce, one of the hardiest of trees in its proper climate, is found sensitive to spring-frosts in the latitude of Paris. The *Sequoia gigantea*, planted at 1,250 meters elevation, in Ménoire, France, after supporting the extreme rigors of several winters, perished in October, 1869, under an early autumnal frost.

The conifers of the Pacific coast are found unsuited to cultivation of many parts of the Atlantic States where they might be expected *à priori* to be favorably located. In their native region, they are accustomed to alternately wet and dry seasons, and after a dry summer in their new location, they are found to start with a new growth in our fall rains, only to be killed off by the frosts of the following winter. It is apparently from the differences that prevail in this respect, in our Rocky Mountains, that the conifers from thence, as a rule, do better in the Atlantic States than those from California and Oregon. In fact, the failure of the latter has come to be so general, that experienced nurserymen in the Atlantic States and Mississippi Valley have become quite discouraged in attempting to cultivate these trees, when brought from a region where the seasons are marked by a strong contrast of wet and dry weather.

[2] Upon this subject the reader is referred to the work by the Hon. George P. Marsh, entitled "*Man and Nature, or Physical Geography as Modified by Human Action*" (1864), and to his later edition, entitled "*The Earth as Modified by Human Action*," for a multitude of facts bearing directly upon this subject. The titles which he quotes lead to a very extended study of this question. In citing from authors we have endeavored as far as might be, to bring later evidences and facts not mentioned by him, presuming that the reader who is carefully studying this subject, will avail himself of the information which this author affords.

[3] Kalm, who traveled in America in 1749, notices a supposed change of climate.

Volney, the French traveler, who visited our country toward the close of the last

In Minnesota the winter of 1872–'73 was long continued, and extremely cold, with fierce winds without a parallel in the history of the State. The preceding autumn was dry, with slight rain-falls, succeeded by a light fall of snow, and severe freezing of the ground, the frost extending to a depth of three to five feet. This inclement winter was particularly fatal to fruit-trees. The trees appeared to root-kill, from lack of moisture in the soil, as in some instances where the soil was moist, the trees suffered but little. The loss of evergreens in the winter referred to was widespread, and extended through an extensive region in the Northern and Eastern States. In Wisconsin, where the loss was severe, it was noticed that the rain-fall of October and November, 1872, was less than the average, and that the early freezing in December prevented absorption by the soil. This condition continued, with occasional dry thaws, until spring, with most disastrous effects, especially on dry sandy and gravelly soils, while it was much less, if indeed at all, on clay lands, where from the retentive nature of the soil, the roots could not freeze dry.[1]

The *real* difference in temperature between two places, as shown by a thermometer, may be quite small, while the *apparent* difference, as judged by our sensation, may be very great. In a dry atmosphere, and exposed to the winds, the perspiration from our bodies is rapid, and its cooling effect may be painfully severe, while in a humid and sheltered situation we would scarcely realize the cold that might be equally great. This relative difference must be the same with all animal life, and the need of shelter for stock against cold drying winds becomes greater as the climate is drier. Passing to the vegetable creation, we find the principle applied to fruit-trees, evergreens, and other trees not of native growth, and not wholly accustomed to the climate, which depend for success quite as much upon shelter as upon goodness of soil. In the

---

century, notes the fact that changes had been observed in the climate, in proportion as the lands had been cleared. (*Tableau du Climat et du Sol des Etats-Unis*, 2 vols., 4to, Paris, 1803.)

Liancourt, another French traveler, notices the belief that the summer heats in Canada were more fervent, and the winters cold more transitory than formerly.

Dr. Rush records a belief that the springs were colder and the autumns milder than formerly, the rivers breaking up earlier in spring and freezing later, &c. (*American Museum*, vi, vii.)

Thomas Jefferson says that the snows in winter were neither so recent nor so frequent as formerly, and sums up with the conclusion that the summers were longer, the autumns later, and the winters shorter and lighter than in former years. These changes upon clearing lands were not gradual and slow, but quick and sudden, in proportion to the extent of cultivation.

Noah Webster, in an article written in 1799, "on the supposed change in the temperature of winter," and revised in 1806, examines a great variety of authorities, ancient and modern, leading him to the conclusion "that the weather in modern winters is more inconstant than when the earth was covered with wood, at the first settlement of Europeans in the country, that the warm weather of autumn extends further into the winter-months and the cold weather of winter and spring encroaches upon the summer; that the wind being more variable, snow is less permanent, and perhaps the same remark may be applicable to the ice of the rivers. He attributes these changes to the exposure of the ground from clearings, and the greater depth of freezing of the earth in winter, but he did not find evidence that there was any actual diminution of the aggregate amount of cold in winter, however much its distribution among the seasons may have been disturbed. (*Collection of Papers on Political, Literary, and Moral Subjects*, pp. 119, 162.)

It is needless to cite from classical authors to prove the annual freezing of the Tyber, the ancient rigors of the climate of Gaul, or the inclement winters of Macedon and the Thracian Bosphorus. The vine and the olive are now cultivated in regions once described as scarcely habitable by man. The vine is now raised in Russia as far north as 48° 15′. In France it does not thrive beyond 47° 30′ north latitude. (*Aperçu statistique de l'Agriculture et Sylviculture et des Pècheries en Russie.* J. Wilson, 1876, p. 11.)

[1] See *Transactions of Wisconsin Hort. Soc.*, 1874, p. 95.

western prairies this shelter is needed at all seasons, and quite as much in summer from drying southwesterly winds as in winter from the "blizzards" from the north and northwest.

With respect to the influence of forests upon temperature, otherwise than by protecting winter snows, obstructing the sweep of winds, and maintaining humidity of climate, some have endeavored to show that a degree of vital heat may be maintained through the action of vegetable organic life. We do not regard this as proven, beyond the effects due to condensation, evaporation, and other changes that may imply the evolution or absorption of heat.

Trees are poor conductors of heat, and come but slowly to an equilibrium of temperature with the surrounding air. While the maximum temperature of the air is usually at about 2 or 3 o'clock p. m., that of the tree is much later. They therefore, in some degree, carry the warmth of the day into the night, and the coolness of night into the early hours of morning.

WINDS: IMPORTANCE OF SCREENS, WIND-BREAKS, AND SHELTER-BELTS.

These prove an important agency in the distribution of rains, by bringing humid air from the sea or from over other areas where evaporated. They may also prove injurious by their drying effects, as is often felt in the Western and Southwestern States, where drying southwest winds in summer have proved very injurious to agriculture, and especially to fruits. The utility of screens and wind-breaks, is more fully considered in a separate article upon this subject. It is observed in all countries, that continental winds are drying in their effects, and the general prevalence of winds form a westerly point in the Atlantic States, so far as these come from across the treeless plains, may doubtless serve to explain the reason why our climate, on the whole, is sensibly drier than in Europe. Our northwesterly and northerly winds are also for the most part cold and dry, while those from an easterly or southerly point, more generally in the Atlantic States, bring rain. The effect of winds upon our agricultural interests deserves more particular notice.

The influence of strong winds, which blow from the northwest through the dry season in the region around San Francisco, and are drawn by the ascent of heated currents far into the interior, has been noticed by Dr. J. G. Cooper [1] as having an effect upon the tree-growth, the species being few and the growth small, as compared with places further inland and at greater elevations. In some places the trees were bent almost to the ground, and at a place where the Coast Range was depressed to a height of 350 feet for a distance of ten miles square, the winds blowing inland had sufficient force to limit the tree-growth to scattered groups on the eastern or sheltered slopes of the hills. Other openings along the coast, known to sailors as "wind-gaps," show the same peculiarity. The effect becomes less with altitude, but dryness has more influence, and where these steady winds prevail the slopes that also receive the sun longest present the most barren aspect, although along a coast exposed to the greatest rain-fall and most fog. The winds, therefore, appear to influence tree-growth by their drying power, and by their coolness, and sometimes by their force, as is observed among the Rocky Mountains near the timber-line.

At a special meeting of the Michigan State Board of Agriculture, held January 8, 1867, a resolution was passed directing T. T. Lyon and the secretary of the board (Sanford Howard) to present a memorial to the

[1] *Proceedings of the California Academy of Sciences*, March 16, 1874.

legislature on the subject of the injurious destruction of forest-trees in that State, the importance of checking the evil, and the expediency of encouraging the planting of trees as a means of shelter and protection to crops, fruit-trees, &c. A special report[1] was made by a committee of the House, whereof R. C. Kedzie was chairman, and the subject was considered in its various relations, but more particularly with reference to its agricultural importance. The effects of woodlands upon the heat, moisture, and winds were noticed, and, although, no meteorological records exist for showing the conditions that existed in a primitive state, facts were not wanting to prove that changes in the climate had already taken place. The winters within the last forty years had been growing more severe. Thirty years before, the peach was one of the most abundant fruits of the State, easy to cultivate, and the tree bearing it early; it was planted everywhere, and yielded its luscious harvest, especially in the southeastern part of the State. Then, frost from May to October was unknown, and spring-flowers appeared in January, in Lenawee County. Now, the peach is a most uncertain crop, and unseasonable frosts may happen. The report further says:

The destruction of the wheat as well as the corn crop is becoming a matter of great anxiety to cur farmers in many sections, and the winter-killing of the clover in the eastern part of the State, last winter, not by "heaving," but, apparently, frozen dead in the ground, and appearing black and rotten in the spring, may be another proof of climatic changes of great significance to the farmers and the dairymen.

An excess of evaporation over rain-fall had been observed, and clearings, which tend to greater dryness by exposure to winds and to the sun might increase this disparity to a degree highly prejudicial to agriculture.[2]

The need of shelter from drying winds, in an agricultural country was next considered, and facts were cited from an address by T. T. Lyon, as showing the results of improvident clearing in Michigan, and especially the southern part. He says:

The natural result of this wholesale destruction is manifesting itself in the higher winds, the more sudden changes, and the more extreme cold of our winters. * * * Two years since, at a similar meeting, I availed myself of the opportunity to urge upon the agriculturists of the State the importance of action in this matter. During the next winter the wheat crop of the entire State, from the want of the usual covering of snow and the general lack of shelter from wind and sun, was diminished in amount more than half, a loss to the State, in a single year, of more than 5,000,000 of bushels.

The committee proceed to notice the effect of shelter upon crops and the value of even slight protection, and, citing again from Mr. Lyon's statement, say:

In many parts of this State, it is found that if farmers harrow their wheat and then roll the ground smooth, the crop is usually an entire failure; if harrowed and not rolled, a partial crop is secured; but if plowed with gang-plows, the furrows running north and south, a good crop is almost certain.

The reason was found in the slight protection from the biting southwest winds and the shelter for snows which these furrows afforded. A dead furrow, running north and south, would preserve a streak of green through a field otherwise dry and bare; a fence would protect a still greater breadth; a hedge more, according to density and height;

[1] House Document, No. 6, Legislature of 1867. See, also, Appendix to Report of Michigan Board of Agriculture of 1866.

[2] At the Agricultural College, in Lansing, observations from March to November, in 1865 and 1866, showed an excess of evaporation amounting to 6½ inches in the former year and 2¼ in the latter, or 25 and 8 per cent. in excess of rain-fall.

Mr. I. A. Lapham, LL. D., of Milwaukee, made observations extending through five years, by exposing a basin of water and measuring the depression with a micrometer screw every morning, and his general result of the period gave an annual mean of 23.61 inches rain and 32.58 evaporation, a difference of 8.97, or 37 per cent. of the former.

and a body of timber secured a fair crop over a still greater breadth, often amounting to the entire field.

Among the remedies proposed, the committee recommended the exemption of timber belts of moderate width, running north and south, from all taxation while left in forest. The needless waste of timber in fences was also mentioned as avoidable, by amendment of the fence law, under which the supervisors of a county might compel the owners of stock to fence them *in* instead of requiring the neighbors to fence them *out*. The planting of shade-trees on the roadsides was also suggested, as so much toward the needed shelter belts, and clearly within the province of law to encourage and require.

Mr. Calvin Chamberlain, in a paper read before the Maine Board of Agriculture (1868), in speaking of changes of climate in Maine, since settlement, remarks:

> The first settlers in the counties of Kennebec and Oxford raised good peaches in abundance. This fruit retired gradually from Maine, quit Southern New Hampshire, lingered for a time in Massachusetts, and has finally been driven from all New England, except some favored spots where shelter has been provided.

Mr. D. C. Scofield, of Elgin, Ill., in a paper read before the Northern Illinois Horticultural Society (iv, 60), speaking of the influence of forests on fruits and fruit trees, says:

> In the early settlement of wooded countries in this latitude, and still further north the peach flourished abundantly, but as the forests were cleared away they as surely failed. The apple orchards are suffering, and, in a sense, barren, when compared with their fruitfulness in former years, and no condition of the soil, either natural or artificial, within the scope of human knowledge, has secured a remedy.

Fifty years ago the peach grew thriftily on the Island of New York and on Long Island, and later, in New Jersey, where it has now become uncertain, so that Delaware[1] and Maryland now supply our principal markets. We can scarcely suppose that any changes of soil have occurred in noticeable degree, within the memory of living persons, and must ascribe these changes to climate, and especially to drying winds and spring frosts. The former promote evaporation, and the latter, although coming on the same dates, and of the same degree, would do more damage, because in an open country the snows disappear earlier, and vegetation starts sooner, than where it has been retarded by lingering snows.

The value of woodlands as a shelter from sweeping winds is, perhaps, quite as important as their influence in moderating the extremes of heat and cold. If we enter a grove in summer while the winds are sweeping over the plains, all is calm within, although the tree-tops may be swayed, and we hear the commotion above, that scarcely affects the atmosphere nearest the ground. The quiescence of this lower stratum of the air in woodlands, is, in fact, one of the reasons why the evaporation from the soil is there less rapid, and the humidity greater than in exposed situations in the fields. A careful observer has noticed a practice abroad,

[1] A writer in the *New York Tribune* (semi-weekly), October 6, 1874, in speaking of the peach crop of Delaware, says: "Already we hear of failure to realize fair crops in that State, owing to our old difficulties of the 'yellows,' and the killing of the fruit-buds by excessive cold appearing in their orchards, and although I do not claim to be a prophet, or the son of a prophet, yet I will venture to say that within the next ten years, peach-growing in Delaware will be abandoned on this account, and our supplies will be derived from Virginia, the recession of supply being continually to a warmer, or, rather, to a more equable climate." This writer remarks a corresponding failure in apples, pears, and cherries, and attributes this loss of fruits to increased cold in winter, from the influence of sweeping winds. He suggests shelter belts, or screens of some kind, and the selection of sites for orchards that are sheltered on the northerly and westerly sides by woodlands.

which shows the benefits to agriculture, which might be followed with infinite advantage with us:

In most parts of Italy, mulberry trees are planted over a large part of the fields under cultivation, and tall trees (usually Lombardy poplars), are left along all the boundaries and division lines in this country and France. The consequence is, that the violence of the winds is so checked that all the operations of husbandry are pursued in comfort, and scarcely any tree is observed to lean in any particular direction; whilst, on the contrary, in New England, near the coast, nearly every tree has a very decided leaning toward the northeast.[1]

Wind-breaks for orchards.—At the winter meeting of the Nebraska State Horticultural Society, held at Omaha January 3, 1873, the subject of orchard-planting being under discussion, some interesting results of experience were presented, which are worthy of notice.

Judge Mason made a statement of his experiments, failures, and final success. In his first trial, he had begun on the raw sod, on the rolling prairie, by spading deeply, in spaces 8 feet square, and planting apple trees, but of this planting every tree died. He then broke up the prairie, cultivated the soil for two years, and, in 1860, set out 200 apple trees, including some 15 or 20 varieties. A killing frost occurred October 22–23, 1864, and a snow 6 inches deep, and the thermometer below zero. His *Red Astrichan* trees were not injured; *Maiden Blush* was killed; *wine sap* some injured but not killed, and the *Jenneton*, *Romanite*, and *Yellow Belleflower* some hurt, but not killed. His preference was for the *White Winter Pearmain*, both for profit and hardiness, and he advised the planting of the *Jenneton* largely. His first orchard had a wind-break on the west but not on the south. His experience was, that they wanted a wind-break all around, but, if they could not have that, then plant it on the south. They would notice that almost all trees sloped to the north. The prevalent wind was from the south, and on that side the trees were liable to be sun-scalded, and he would therefore put the wind-break upon the south side first.

In regard to planting—out of 100 trees set the day of their removal from the nursery, he had not lost one. Of 100 that had been taken up in the fall and heeled in, he had lost 75. Of 200 pear trees he thought he he had lost 5 per cent. Out of 75 shipped from Bloomington, Ill., he had only lost 8. His were only dwarf pears, set in 1860. Out of 100, he had lost 10 the first year, the others grew and came into bearing in three years. None were lost in 1864, but in 1865 he left them without hilling, and the next spring they leaved out, but were soon after all dead. He planted 75 others, and every winter he has hilled up around the quince root till the last, when he happened to be away, and lost 12 that were in bearing. The pear was not tender, it was the quince root or stock. They all bore well last year. He would rather hill up with earth than with manure. He would plant upon the highest spots on his farm, and, as to a slope, the northern was the best.

The best shelter was the gray willow, followed by evergreens inside. The willow grew rapidly, and if planted at the same time as the trees, the ground could be cultivated for two years, and the cornstalks left, after which the trees would take care of themselves. The distance at which he planted in his old orchard was two rods, and when the trees attained their growth their branches would touch. His rule was now to plant 16 feet each way, and when they became two thick, cut out for fire-wood; to cultivate for two years, or not to exceed three, and sod down. The object ought to be to send the trees into winter quarters in

[1] Geo. B. Emerson, in his preface to second edition of *Trees and Shrubs of Massachusetts*, p. xiii.

good condition, so that they would not kill. It was a mistake about winter-killing; they should call it fall-killing, for it was while the sap was descending in the fall that the mischief was done by the early frosts. The judge related how he had kept a weeping willow from being winter-killed, by stripping off all the leaves early in the fall. The wood then had time to harden, and the frost had no effect upon it.

In answer to some questions, the judge said that in places where land was abundant and timber scarce, he should plant as large a wind-break as possible, consisting of willow, cottonwood, ash, black walnut, and box elder.

The question arising as to "how wide a wind-break should be planted for an orchard," Mr. Perry Walker replied that he had 40 acres in orchard, inclosed with hedge, and five rows of cottonwood on three sides. There was no protection on the east side, and he did not think best to plant rows of trees for protection through the orchard.

Mr. Masters thought best to plant trees for a shelter among fruit trees, and would prefer evergreens of tall-growing kinds.

In the discussions of the Nebraska State Horticultural Society, the subject of wind-breaks received attention at a late meeting, and the opinion was expressed, that six rows of trees was sufficient for 40 acres. Mr. Barnard, of Pawnee County, stated that a wind-break will protect an orchard a rod for every foot of its height. He only wanted shelter on the south side, or at most south and west. To surround an orchard with a wind-break would be to restrict the sun and air to the injury of the orchard, and especially the peach trees. Mr. Budlong, of Franklin County, had planted two rows of white willow, which are 6 to 8 feet high at two years' growth, and 12 feet apart. He had also planted four rows of cottonwood, 16 feet apart, and four rows of black walnuts, the same distance; on the east and west rows of willows, and on the north, willow and black walnut. Professor Thompson thought that an old orchard would protect itself, and that a young one would need protection against the worst summer winds, the trees being 25 feet high, and belts of such trees every ten rods.

The protection afforded by a belt of trees or a hedge must depend, of course, upon the nature of the surface, whether level or sloping, and very much upon the prevailing course of the winds. In the valley of the Rhone, Becquerel says "a simple hedge two meters in height is adequate protection to a distance of 22 meters."[1] In Algeria it has been proposed to plant shelter belts of trees at a distance of 100 meters apart.

Mr. I. A. Lapham and associates, in their report on the disastrous effects of the destruction of forest trees in Wisconsin (p. 19), mention nursery belts in rows 25 to 30 feet high, in New Jersey, that increased the yield of trees and adjacent farm crops 50 per cent. above that of places not protected, and an English thorn hedge allowed to grow up 20 feet or more that sheltered and saved from winter-killing a crop of wheat within its influence.

Prof. R. C. Kedzie, in an article on the meteorology of Central Michigan,[2] notices that the southwest winds are the most prevalent in that region, as well as the coldest, and insists upon the importance of placing timber belts on that side of the orchard, barn, and house, as a shield against the cold storms from that quarter. The protection afforded by large bodies of open water had been noticed in a cold storm, in which the temperature of Grand Haven on the eastern shore of Lake Michigan was 20° higher than at Milwaukee on the opposite side of the lake.

---

[1] Becquerel, *Des Climats*, &c., p. 116.
[2] *Michigan Board of Agriculture*, 1865, p. 241.

In Vermont, the south and southwest sides of an orchard have been mentioned as more particularly needing a shelter against winds; and screens at distances of 20 or 30 rods were thought to be useful, with occasionally an evergreen in place of a fruit-tree in exposed places. The arbor vitæ was mentioned as useful, but preference was given to the Norway spruce.[1]

A wind-screen, if close, affords some protection on the windward side, by the calm which it produces. It is noticed that sheep and cattle will sometimes find shelter on the front side of a screen.

A writer in the *New England Farmer* (vi, 350), in noticing shelter, and its effect upon farm stock, says:

It is indeed astonishing how much better cattle thrive in fields, even when moderately sheltered, than they do in an open, exposed country. In the breeding of cattle, a sheltered farm, or a sheltered corner of a farm, is a thing much prized; and in instances where fields are taken by the season for the purpose of fattening cattle, those most sheltered never fail to bring the highest rents.

In the grazing regions of Texas, cattle seek the timber on the approach of a storm, and stay there while it continues, and on the western plains they will retreat before a storm a long distance to gain shelter.

The freshness of pastures interspersed with trees, is well known in the dairy regions of the north, and is doubtless partly due to the shelter that trees afford to the winter snows.

The prevalence of dry southwesterly winds in the Western States has suggested a practice, quite advantageous in fruit-trees, of leaning the trees toward that point, so as better to resist the wind, as well as to shade the trunk from the sun. It is also found a good practice to allow the tops of fruit trees to grow low, so as better to resist the drying effects of the wind and sun. The same reasons would lead to a like practice with the outside rows of forest trees, especially on the sides of a grove most exposed. It would be unnecessary in the interior, as if properly set, the trees would shade one another sufficiently for all purposes, after they have got well started.

Dr. John A. Warder, in a paper read before the Northern Illinois Horticultural Society,[2] in speaking of shelter for fruit trees, says:

Evergreens may be planted here and there through the orchard with very great advantage. For this purpose the most robust varieties should be selected, such as the Scotch and Austrian pines, and the beautiful Norway spruce, from Europe, or our own native, the noble silver pine, the red or Norway pine, the *Banksiana*, the white spruce, the common red cedar, and arbor vitæ. All are robust and hardy, rapid growers, and valuable for shelter and for timber, but *screens* are what we need. A single row of such trees outside will afford a great deal of protection from the winds after a few years, indeed from the first; but a closely-planted belt of 2 or 3 rows will be much more effective. These should not be set too near the orchard trees; two rods may be allowed, or, if closer, the outer rows of the apples can be cut out in a few years to make room for these nurses when they may require more space. The evergreens may be set in double or triple rows, and alternately, so that every three shall be opposite the space in the next row. In planting a triple row it is well to set the *Pinus strobus* in the middle, with Norway or white spruce, or red cedar on either side, planting these from 8 to 10 feet apart. * * * The hedges should not be set too closely to those shelter-belts, especially where they are allowed to grow high for screens. At one rod, they will soon interfere with the trees, so that a space of two rods may be better—outside the belt. In large plantations it may be well to set rows of evergreens across the orchard, dividing it into two or more sections. For this purpose, a single row of Norway spruces will produce a very fine effect, or the American arbor vitæ can be used as an evergreen hedge, and kept to a height of 10 or 12 feet, if desirable. Both these plants are eminently well adapted for close shelters, and will bear the shears, which help to make them a perfect screen and wind-break. Deciduous trees are also very desirable as shelter belts, and for the sake of immediate effect the quick-growing kinds are preferred, such as the soft maple, or even the white willow, but more especially the Eu-

[1] C. G. Pringle, in *Vermont Agricultural Report*, 1872, p. 69.
[2] *Transactions*, fourth meeting, p. 68.

ropean larch. * * * These should be planted pretty thickly, say 5 or 6 feet apart, and in strips of 3 or 4 rods wide, to produce their best effects, both as shelters and for timber, for which they are highly recommended. Do not be misled by the swampy habit of the native tamarack, nor induced to set the larch in the sloughs, which should be planted with willows.

Protection to nurseries; French experience.—Screens or wind-breaks [says Carrière[1]] are indispensable to a nursery, as well to shield the plants from the hot sun, as to shelter other kinds from cold in winter. Their direction will vary according to the contour of the ground, but they should almost always run east and west. Wind-breaks, according to local circumstances, may be oblique, either to the north or south, and it may be necessary to have them in a line between these points, for the climatic conditions under which the nursery is placed, and surrounding objects, such as a mountain, a grove, a river, or a lake, or large buildings, may determine the course of prevailing winds, and observation alone can decide as to which are the most prejudicial. Having settled upon the direction of the lines, the next thing to determine is the species with which they should be planted. Some kinds are preferable to others, and they vary with the soil and climate. We always prefer evergreen trees; but these are for the most part of slow growth, and when the intention is only to shelter the nursery in summer against the ardor of solar heat, the choice is left among the deciduous kinds of rapid growth, which do not shed their branches too near the ground, and of which the foliage and aspect is sufficiently ornamental. There is another consideration that is not less important. We should not select trees with long, tracing roots, which, by spreading, so to speak, "*eat up the soil*," by robbing the plants even when growing in pots. In these respects we have two species of the *Tamarix* that unite almost all the good qualities required, the *T. tetrandra* and *T. Indica*. These trees are very accommodating as to soil, have a hardiness well tried, and a very rapid growth—endure prolonged drought without injury, and appear indifferent to excess of moisture. Their roots are small, close, and but little spreading; they bear trimming, and their elegant foliage of light, feathery spray form plumes of most pleasing effect, while their blossoms of rose, flesh-colored, or almost white tint, in spikes or branching panicles present a most agreeable aspect. The first of these blooms in April and May, and the other toward the end of summer and in autumn. The tamarisk grows easily from slips, which may be set from November to February, and will form the first season shoots 1 to 2 meters high. They should be set about 8 inches apart, and may be cut back when 20 inches high to make them thicken up. Sometimes a trellis of grapevines will answer every purpose of a screen for young fruit trees.

But, as we remarked at first, the evergreen species are generally employed as a screen, and of the conifers the *Biota orientalis* is particularly suitable when the soil is light, warm, and but little calcareous. In places where the soil is more moist, and more clayey, and the climate more severe, the *Thuya occidentalis* is much more hardy. The common yew (*Taxus baccata*) is also very precious as a wind-break. Its foliage is very dense, and of a green so deep that it borders closely upon black, and the perfect docility with which it bears clipping renders it a most valuable tree for a shelter hedge. We sometimes employ the common pitch tree *Picea excelsa*, but this tends to grow to a large tree, and readily sheds its lower branches. The red cedar (*Juniperus Virginiana*) is also sometimes used as a wind-break, and in proper soils produces a fine effect. In many districts of Southern France the pyramidal cypress (*Cupressus fastigiata*) is used to advantage.

Of the evergreen shrubs other than conifers, we have the box (*Buxus sempervirens*), evergreen oak (*Quercus ilex*), the holly, the *Buplevrum fruticosum*, the *Rhamnus oleifolius*, the *Aucuba japonica*, and the Japanese spindle tree (*Evonymus japonica*). The latter may be used when we need shelter of limited extent, for they are generally of low growth. In some places we may plant the *Lauro-cerasus vulgaris, colchica*, and *lusitanica;* and in other cases may employ shrubs with semi-persistent leaves, as the *Rhamnus hybridus, Ligustrum japonicum, ovalifolium*, and *vulgare*. In some privileged localities of Southern and Southwestern France, we may plant the *Rhamnus alaternus, Arbutus uredo, Viburnum tinus*, and a host of other species.

The breadth of space to be reserved between the lines of shelter varies somewhat according to the use, but it should be never less than 2 meters between, because the paths for service would be always of about this width. If there be no necessity of using the ground sparingly, it would be better to give them greater width, so that the plants sheltered may be a little away from the screen, and it would be still better if a path could be allowed on both sides.

Timber-belts for farm protection in Kansas.

Mr. W. Marlatt, of Manhattan, Kans., in a paper read before the State Horticultural Society, in 1875, after alluding to the frequent and severe

---

[1] *Pepinières*, p. 38, 41.

losses of fruit and forest trees in Kansas, and condemning altogether any attempt at planting until the soil was as thoroughly prepared as for corn, he says:

With my present experience as to the peculiarities of the soil and climate of Kansas, I would plant timber only in the form of shelter-belts for the protection of farm crops, the orchard, the stock-range, and the home and its surroundings, being especially careful to shelter the latter from the north, northwest, and northeast winds, leaving the south and east, particularly, open to the sunshine and south winds, which are *nearly* always warm in winter and cool in summer. By planting the shelter-belts on the higher and more exposed ground, where practicable, the value of the farm may be greatly enhanced at a comparatively small outlay, æsthetically as well as practically. From experience and observation, I am of the firm belief that if 40 acres in every quarter-section were thus occupied by judiciously located timber-belts, the remaining three-fourths would produce more than all of it would without the protection thus afforded. I have seen the soil in exposed situations blown away to a depth of 6 inches, or as deep as the land has been plowed, in a single season. An effective shelter-belt would not only remedy this evil, but would serve largely as a preventive of drought; first, by measurably warding off the dry, hot winds that sometimes sweep over the country as a blighting, withering curse; and, secondly, as a shelter for the snow that is otherwise blown away into the ravines and hollows where it is not needed; and, again, in breaking the force of the fierce storms that almost every season do more or less injury to the growing corn and other farm crops.

I recommend the cottonwood for timber-belts, rather than some other more valuable species of wood, from the fact that it takes kindly to our prairie soil, grows rapidly and tall, and is yet able to withstand the force of the winds; and, on the whole, seems to fill the bill more nearly than any other at hand just now. To render this shelter more effectual, I would plant out a single row of box-elder, or some other spreading or low-heading tree on either side of the cottonwood belt. I recommend the box-elder for this purpose, from the fact that it is never stripped of its leaves in summer, not even by the omnivorous hopper. As this belt attains to age and size, it must be systematically thinned out, by removing from year to year a certain number of the less likely or less-thrifty trees, else in the course of time you will find them dying out *en masse* for want of sufficient nourishment to keep up the vital force necessary for their continuous growth and well-being. As they are removed thus gradually, other varieties of forest-trees may with success and profit be made to take the places thus vacated, and for this purpose, where they can be had easily, I would especially recommend red cedar. At all events, in planting a grove, stick to our *native* forest-trees, rather than any of foreign growth, however highly they may be extolled by parties interested in their sale, or without an experimental knowledge as to their adaptability to our peculiar soil and climate.

A few words as to the best mode of planting such a belt must suffice for this phase of the subject. Supposing the ground to be in proper condition, and the trees ready to hand, with team and plow strike a straight furrow through the center of the piece to be planted, and back-furrow three rounds, going 8 to 10 inches deep. Then with an armful of small trees pass along in the furrow, and at every 4 feet stoop down and place a tree in the loose soil thrown up at the last round, letting the top lean toward the ridge. Then turn on a furrow, and so on at every fourth furrow, until a dozen or more rows have been thus put in their place. Then passing along each row, straighten up each tree with the hand, and at the same time press the earth firmly about it with the feet. In this way, with one man to run the team, and two others to put the trees in place and straighten them up, two acres may be planted with 5,000 trees in a day, at a cost, aside from procuring the trees, of not more than $5. In this manner, the farm, when comparatively level, may be surrounded and intersected, where necessary, with shelter-belts, at a comparatively small cost, and the value of the place may be doubled in five years.

In orchard and small-fruit culture, I consider protection of some sort an absolute essential to success. I have found most kinds of small fruits doing best when partially sheltered from the hot sun; while the sad effects of the burning southwest winds two summers ago is but too apparent in nearly all the orchards of Kansas to-day. In my own, I have found, generally speaking, the least damage done where most effectually sheltered on the south and west.[1]

In asserting the value of wind-breaks to growing crops, or as a shelter for stock, it is impossible to appraise the benefit pecuniarily with anything like the exactness with which we measure and sell the actual products of the forest. We may, however, sometimes arrive at a close approximation by comparing the differences shown where the protection

[1] *Transactions of the Kansas State Historical Society* for 1875, p. 113.

is present or absent. In illustrating this point, Mr. O. B. Galusha, of Illinois, has presented some instructive examples:[1]

In the year 1862, at the time when spring-wheat and oats, in the northern portion of the State, were just past their bloom, and a portion of the grains in the milky state, we were visited by a storm from the northwest, which swept over this portion of the State, prostrating nearly all the grain not sheltered by timber. * * * In one locality a single line of broad and tall willows, closely planted, proved a sufficient check to the wind, so that a field of wheat adjoining it on the east stood erect and was harvested with a machine, while in exposed situations the shrunken grain, if saved at all, was often gathered by the slow and tedious process of hooking it up with scythes. Many thousand acres were left to dry and were burned upon the ground, which two or three weeks before had promised abundant crops. The extra expense of gathering the grain of that harvest could not have been less than 50 cents per acre on the whole amount harvested. I traveled quite extensively over this portion of the State before and soon after the harvest of that year, and am convinced that one-half the value of the wheat and oats in the territory passed over by that storm was destroyed by it. There were sown in that year, as per census reports, in the 30 counties lying north of the Burlington, Peoria and Logansport Railroad, about 1,200,000 acres of wheat, and at least one-fourth as many of oats. Allowing one-tenth of these crops to have been protected by timber, we find the loss to have been equal to 540,000 acres of wheat and 130,000 acres of oats. Computing the wheat at 15 bushels per acre and the value at 50 cents per bushel, the oats at 30 bushels per acre and price 20 cents per bushel, we have the sum of $4,860,000 as the cash value of property in these two crops alone, which was destroyed in a single storm in an area of a little more than one-third of our State. Allowing 150,000 acres to have been burned, or not harvested, and adding to the amount of loss per acre of the remainder of the nine-tenths (lodged grain), equal to $600,000, it swells the amount to the enormous sum of $5,460,000. Let us see how much it would cost to plant and cultivate screens to prevent such losses. A double row of white or golden willows, with trees in the second row set opposite the spaces in the first, planted upon the west side of every 80-acre lot, would doubtless prove sufficient, as they would, at the age of 12 years, form a dense wall of foliage about 40 feet high, and would, of course, increase in size for many years thereafter. These would cost, per mile of screen, about as follows: Average value of two acres of land, at $40 per acre, $80; preparation of the soil and planting with strong cuttings, $10; cultivating the first two years, $20; making a total cost, with purchase-money of the land, $110. After two years no care will be needed, save a mulch of refuse straw, to be renewed once in two or three years, the cost of which will be more than repaid in the partial protection which the trees will render previous to the twelfth year.

There are in the 30 counties referred to about 16,625 sections of prairie-land. This will require 66,500 miles of screen if planted as above proposed, making the entire cost $7,315,000. Thus we see, that without estimating the immense damage done to fruit and other crops, the wheat and oats destroyed in that storm would, if saved, have paid about three-fourths the entire expense of growing timber-belts throughout that entire territory.

I think it may be safely estimated, that an average of one-twelfth part of all our crops of grain and large fruits are destroyed by violent winds, which such a system of protection, or its equivalent in groves, would so far check as to prevent the destruction. If this is true, such protection would save to the husbandman and orchardist its entire cost every two or at most three years. Such protection, too, would, by causing the snow to remain spread evenly over the surface, as before hinted, enable the farmer to raise winter-wheat in localities where it is now impossible to do so. If we add to the benefits of the culture already considered, those far-reaching and incalculably valuable climatic influences which would flow therefrom, we must all admit the necessity of commencing this great enterprise at once, and prosecuting it with vigor.

I do not introduce this plan of planting straight belts of trees, a quarter of a mile apart, because it is the most desirable plan which can be adopted, for no man of taste would regard it as such. The eye would soon tire of such stiffness and monotony in the landscape. Tree-planting may be so planned and conducted as to give beauty to the landscape, and at the same time secure nearly all the combined benefits of protection to crops, timber for uses in the mechanic arts, and those climatic influences which we all regard as so important. Of course no rules can be given for such tree-planting. Generally where the surface is somewhat undulating (for we have no hills), the planting should be done mainly upon the higher portions of the farms, and along the water-courses. Where the surface is level, belts may be planted upon the north and west of the farms, with groves upon the least valuable portions. These last would intercept the straight lines and give diversity. But if each prairie-farmer were to

[1] Lecture at the Illinois Industrial University in 1869, published in the second Report of its trustees, p. 356.

follow his own tastes, or adapt his planting to secure the greatest profit in timber or protection to his own farm, planting about one-tenth of his land with trees, it is probable that all the desirable ends which we have been considering will be gained, and the landscape sufficiently diversified to be pleasing to the eye.

Here then * * * we have two pictures presented to us. In the one, we look into the future, and see wide-spread desolation, an extended treeless country, visited by destructive storms, by severe droughts, with its streams dried up, and food for man and beast in such scarcity that the poor can scarcely obtain a supply. In the other, we see a charming landscape, a rich fertile country, a population enjoying all the blessings which flow from peace and plenty.

The following suggestions concerning shelter-belts are offered by Messrs. H. M. Thompson and Son, of Milwaukee, Wis.:

It has been found that belts from 7 to 8 rods in width are, all things taken together, the best. These belts should be planted on the outside with some evergreen whose roots strike deep into the ground and do not spread near the surface, and whose leaves and branches will afford protection from the winter winds. In the center can be placed the deciduous trees. If, however, the farmer wishes first to experiment, and should think belts of this width entail too much cost and labor, belts of two or three rows will be found to make remunerative returns, and even one row planted, say not more than 6 feet apart, will give rich returns in increase of crops, and add very much to the attractions of the estate. The trees for planting should be those best adapted to the soil and situation, and will vary much with different localities. There are, however, certain trees, such as the larch, Scotch and pitch pine, that are so well adapted to dry soils, rich or poor, and the Norway spruce, Scotch, Austrian, and white pines, American arbor-vitæ and ash, which are best for moist, rich soils, and which so fully meet the wants of the farmer that they should always form a large portion of his planting. Belts composed of Scotch pine, Norway spruce, white ash, and European larch, planted from the outside of the belt, in the order named, have been found to meet, in almost every particular, the need for which they are planted, and to afford to the farmer every protection in the way of timber that he can want. The value of such a timber-belt is felt very early, and cuttings for stakes, hoop-poles, bean-poles, fuel, &c., begin much earlier than may be thought; while the after-products of hop-poles, telegraph-poles, railroad-ties, and lumber for general use follow year by year, and are a constant annual source of profit.

Professor H. H. McAfee, formerly of the Iowa Agricultural College, a close observer in forest-culture, in an article on shelter-belts,[1] remarks that prairie-farms need shelter most on the west, next on the north, next on the south, while their usefulness on the east is not so great, though sufficient to call for planting. A good combination for an evergreen belt is 2 or 3 rows of white pine for center, 2 rows of Scotch or Austrian pine on each side, and 2 rows of red cedar or arbor-vitæ outside of these, making 10 or 11 rows, and giving, by different rates of growth, a belt with a conical cross-section, and limbs from the ground up. Another good evergreen combination would be Norway spruce for center, white spruce next, and black spruce and red cedar or arbor-vitæ outside. These kinds were hardy in Iowa, except in too great drought. A shelter-belt of cheap soft wood may be made of two rows of gray or white willow, flanked by one row of Lombardy poplar on each side, rows 8 feet apart. Willow alone is apt to spread too much, and this poplar alone is apt to lose its side branches, but thus combined, the poplar, which is always erect, holds the willow up and the willow grows twigs enough to make a fair barrier. But any kind of tree, except perhaps such thinly-foliaged trees as the walnut and coffee-nut, will make fair shelter-belts, if enough width is given them. At least 10 rows of any of the maples, birches, poplars, or other common woods should be put in the belts, or 8 rows of white or scarlet oak, which hold leaves in winter. Where road-side planting is done to obviate snow-drifting in winter or to furnish shade and shelter in summer, less rows are needed.

[1] *Iowa Horticultural Report*, 1875, p. 292.

Judge C. E. Whiting, of Monona County, Iowa, in reporting to the State Horticultural Society in 1876 (p. 156), mentioned that he had on his farm of 1,800 acres about 40 acres of timber in belts around his fields, varying from single rows to 20 rows, and of different ages from 18 years down to 1; but mostly from 5 to 12 years. In regard to the influence of these belts on the growth of crops, he says:

As my groves increase in height, I still find that the visible influence of this protection—with almost mathematical precision—amounts to one rod on the ground to one foot height of the tree. Whether from cause or from accident, I will not pretend to say, but leave it for the entomologist to decide—I record, that during the great grasshopper visitations of 1873 and 1876, all my fields surrounded by timber escaped almost wholly uninjured. The same was true of the farms opened in our Missouri bottom timber. Will Professor Bessey please inform us if a Colorado locust, with an eye to beauty and utility, respects a field surrounded by green growing trees? We know from long experience that the summer storms, the early frosts, and the fierce, unrelenting winter blizzards *do* pass these fields by uninjured and unscathed, and why should not a locust as well? I would make no material change in my order of planting; on our treeless prairies, where timber is wanted quick for fuel, shelter, and other purposes, the cottonwood, in my estimation, still stands *king* among all our native trees. I am now using my round cottonwood posts cut from my young thrifty-growing trees, peeled, seasoned, and the posts set in the ground, boiled a few minutes each in coal-tar, at an expense of about one cent each, that bid fair to outlast oak not so treated. Maple, willow, ash, and walnut should follow in the order named, the latter to be planted on the deepest soils.

Need of wind-breaks for the protection of human life.

A winter seldom passes without deaths from storms on the prairies of the Northwest. Mr. James T. Mott, in an article on timber culture in the Iowa Horticultural Report of 1872 (p. 109), after 17 years' residence in Iowa, says:

I have many times wondered how it could be that people were so easily lost in these storms; why it was that a man in good health, strong in limb, and well clothed, could not go a few rods from his house to the barn, to care for his stock, without danger of death; why whole sleigh-loads of people were frozen to death within a hundred rods of dwellings, and this in the same location where I was living. But lately it has been my fortune (or I thought at the time misfortune) to be caught in one of these storms in Minnesota; and it took only a short time for me to see through the whole thing. I felt the wind first blowing softly from the south; in 30 minutes, it changed to a fierce gale from the west, bringing with it a bank of snow that would compare to the rush of water as the flood-gates are opened in a mill-race, and with a force that no man or team could travel against it a mile, as steady as in a bellows run by machinery, being filled with snow as fine as the finest dust, and so thick one could not see 10 feet, filling the eyes and nostrils of man and beast. The storm lasted three days, * * * and the news is of hundreds dead; people frozen in stage-coaches, whole sleigh-loads returning home from town, men standing dead with hand on the stable-door latch, others that saved themselves by burrowing in snow banks—little children lost going home from school, passengers in railroad-cars two days without food, &c. * * * More people have been frozen within the last year, in Northwest Iowa and West Minnesota, than were ever murdered by the Indians in those counties since their settlement. * * * The people are now petitioning their legislatures for some kind of protection from these storms, asking that wire fences and storm-houses be built along the traveled roads—asking them to do something for their safety. I see none that would do but timber-planting. It alone would stop these terrible winds, modify the climate, and furnish land-marks for the traveler.

Screens of woodland as a barrier against the progress of insects.

The Hon. J. G. Knapp, of Madison, Wis., in a lecture delivered at the university course at Rockford, Ill., in February, 1870, notices the influence of forests in intercepting the progress of insects and the spread of contagious and destructive fungi. He says:

The chinch-bug of the prairies was lately as much dreaded by those who knew their ravages . . . . , but these can never traverse a belt of thick woods seven or eight rods in width to devastate an adjoining field. The cool damp soil and shade of such a belt presents an impassable barrier to their march, the same as to the grasshopper.

Citing from I. T. Thomas, he continues:

Another important advantage has been occasionally afforded by the shelter of woodlands. It is well known that rust in wheat is commonly most prevalent on low and mucky lands, yet at other times, and in its most virulent form, it seems borne on the wind, and often destroys thousands of acres on all kinds of soil in one sweeping blight. An instance of this kind occurred in Northern Indiana in 1840. Early and late sown, on compact and spongy soil, on hill and dale, cleared land and prairie, were all alike affected. In every instance, however, where the crop was sheltered by woodland it was least injured. An extensive farmer in Ontario County, New York, informed me, some years ago, that out of two hundred acres of promising wheat, which he then had growing, all was completely destroyed *except those portions sheltered by woods*, the total loss being four or five thousand dollars, most of which he believes would have been saved had his land been protected by timber belts.[1]

Frost and dews, as affected by timber belts.

The protection of winter grain from winter-killing by proximity to woodlands has often been noticed, and as an obvious inference, the prevention of this injury by the planting of timber belts has been suggested.

The radiation and cooling of certain soils in summer nights is well known to depend upon the absence of clouds or other covering to intercept and prevent it, and from this cause there may be no dew under the shade, or within the influence of an isolated tree. It is during still nights, when this process is most active, that summer frosts generally happen. But on the other hand, the dew is more commonly abundant near the border of a woodland, where the radiation may be less, yet the moisture is more, and a less amount of cooling may be sufficient for the precipitation of dew.

It has also been noticed that a windy night is seldom a dewy one, and it is quite probable that the greater amount of dew along the borders of a grove may be in part occasioned by the calm in the air. "When the dew is formed," says Kaemitz,[2] "it often disappears very quickly, if the wind rises, or the atmosphere is disturbed," a circumstance most likely to occur in the open fields. Under like conditions of moisture, the greater amount of dew there is the greater is the cooling and the *tendency* to frost; and instances may occur in which places within the calm on the lee side of a woodland might freeze, while the open country exposed to a gentle wind might escape.

Shelter-belts for preventing highways against the obstruction of drifting snows. Project of a law.

The importance of this subject is often realized in the Northern States, where snows even of moderate depth, in places peculiarly exposed to heavy winds, will often cause serious obstruction by drifting across the roads.[3] Various devices have been employed to prevent these evils, such as high and close board fences, the removal of all fences in winter, or what is nearly equivalent, the use of wire instead of rails or boards; but none of these appear so effectual as a close and well-kept screen of

[1] *Third Report of Trustees of Illinois Industrial University*, p. 361.

[2] *Meteorology;* Walker's Translation, p. 107.

[3] Travellers on the Union Pacific and other railroads crossing the Plains, must have noticed the devices suggested by experience for arresting these drifts. The snows might not fall more than a few inches deep, but would accumulate in places to many feet in depth. Besides snow-sheds entirely covering the road in places of great exposure, board fences across the direction of prevailing winds, and sometimes 5 or 6 of these in succession, have been placed, with the view of precipitating the snows before reaching the track. Some of these are movable, and are raised two or three times during the winter, as they become buried. In places where the planting of broad evergreen belts is possible, they would doubtless prove an effectual remedy.

evergreen trees, with branches extending to the ground, like the Norway spruce, and of sufficient widths to obstruct the sweeping winds and moving snows. A single row of trees will seldom be sufficient for this purpose, and generally at least three rows will be found necessary. Where liable to injury from cattle might happen, a light fence or hedge of Osage or other thorns might be needed on the exposed sides.

Believing that a law might secure the requisite authority for establishing such screens wherever needed, we submit the following draught as embracing its essential provisions. Some modifications would be necessary to apply it to the local organizations of town or county government in particular States.

AN ACT for the planting of shelter-belts for the protection of roads against drifting snows.

SECTION 1. *Be it enacted, &c.*, That the commissioners of highways [or other officers having charge of town roads] are hereby authorized, upon application in writing by three freeholders, representing that certain parts of the public highways are liable to obstruction from drifting snows, to summon a jury of six disinterested freemen, resident of the town, to view the premises and take evidence as to the facts alleged. If, in the judgment of this jury, a shelter-belt of trees or shrubs along the border of the highway would prevent the drifting of snows in winter, at the places specified, they may, by an instrument in writing, filed and recorded in the office of the town clerk [or other local office of record], declare the necessity for protection within the distances specified, and a sufficient width of land may be surveyed and taken upon payment of its value, by agreement with the owner, or if not, by appraisal, in the same manner as land is acquired for the opening of new roads.

SEC. 2. The said commissioners are further authorized and required, after acquiring the additional width of roadway as above mentioned, to cause the same to be planted with at least three rows of evergreen trees, of such kinds as they may be deemed best suited for the purpose, and as closely together as may be necessary to afford, when grown, a sufficient screen against drifting snows.

SEC. 3. The middle of said shelter-belt shall be, as near as may be, on the outer line of the highway, as it existed before the belt was ordered, and the outer rows shall be set opposite the spaces of the middle row, so as to best secure the objects for which the planting is done. A sufficient fence for the temporary protection of the plantation while young, may be built within the limits of the highway, not more than one rod from the middle line of the proposed screen.

SEC. 4. The planting, protection, and maintenance of such shelter-belt shall thenceforth be a public charge, in the same manner as the repairs and maintenance of the public highways. It shall be discretionary with the commissioners of highways to apply the assessment of labor, of the owner of adjacent lands, to the planting and care of such shelter-belt, or to contract with some person skilled in the care of trees, as they may deem most effectual, for securing its proper growth and maintenance. They shall be required to submit at the annual town meeting, a written report, with a statement of expenses incurred on this account, and such recommendations as they may deem proper concerning it.

SEC. 5. Whenever any railroad company now existing or that may hereafter be formed under the laws of this State, shall deem it necessary to plant screens of evergreen trees to prevent the drifting of snows in winter, and the width of their roadway is not sufficient for this purpose, they may acquire such additional width as may appear necessary for this purpose, in the same manner as land may be taken for new railroads; but land so taken shall be used for no other purpose than the planting and maintenance of shelter-belts as aforesaid, and if not planted, or if abandoned for this use, the title shall revert to the owners of the adjacent lands.

The value of screens against drifting snows has been recognized in Europe, and they have sometimes been planted at considerable expense and under difficult circumstances. The following account of the necessities that led to this undertaking, and the methods employed in its execution, will afford suggestions of value in like attempts at planting in all snowy countries[1]:

Roads laid out over mountains and elevated grounds are frequently blockaded by the snow, the removal of which occasions every year a considerable expense. Travel is especially liable to interruption in those places where the road is a deep cut, be-

[1] *Annales des Ponts et Chaussées*, 3 ser., xvii, p. 111 (1859), it being an article by M. Compte-Grandchamps, engineer of roads and bridges.

cause the snow, driven by the wind, in eddies more or less thick, tends to fall where the disturbance of the air is less felt, that is, in trenches and on the slopes of hills, where it rapidly piles up to the level of the country adjacent, and renders expensive labors necessary to open the way, so as to make it passable for teams. But the way is scarcely opened before it disappears again, as soon as the wind begins to blow, so as to carry the snows before it.

This effect was seen with remarkable intensity before 1849 upon the imperial road No. 82, of Roanne-on-the-Rhone, between Saint-Etienne and Bourg-Argental, upon the plateau called De la République, at the great turn near the village of Ruthiange. At this part of the route the road rises from a point 537 meters (1,772 feet) to an elevation of 1,140 meters (3,740 feet) above sea-level, to clear the Pila Range at the ridge of Grand-Bois, from which it descends toward Bourg-Argental by following the left bank of the Argental Brook, in the course of which it crosses several secondary ravines which join this stream. The storms reign in these elevated regions with a violence elsewhere unknown, and the snows, borne by the winds, are rapidly carried great distances and dropped into the ravines to the depth of many meters. The road then wholly disappears under the banks of snow, and the traveler has nothing to guide his way but the pyramids of stone built at certain distances apart along the way, and the interruption of travel has been so grave an inconvenience, that the mail post from Paris to Marseilles has been obliged sometimes to wait at Saint-Etienne for the road over the Pila to be cleared, before pursuing its course to Roanne-on-the-Rhone, at a cost sometimes of 5,000 francs, to say nothing of losses to private credit and business intrusted to the postal service.

The road was more particularly intercepted upon the naked plateaux, or upon the more steeply inclined slopes, where there was no shelter from the north winds, but through the woods the travel was never interrupted, however severe the storm, and the track when once broken through remained open all winter. But in the exposed parts of the road the trenches were filled up as soon as they were made, and it became necessary to work day and night to keep the road open for travel. The mail post could only be got over with incredible efforts, drawn by 10 yoke of oxen, or from 10 to 15 horses, and requisitions were often made upon the inhabitants of the vicinity and their teams, yet without advantage.

The idea of sheltering the road by planting trees very naturally presented itself. The project was studied to this end in 1847, and put in execution some years later. Those parts of the road where the circulation was always interrupted during the stormy season have been sheltered by four massive plantings of evergreen trees, which are more closely set in the steeper slopes. Their breadth varies from 27 to 83 yards. Two of these screens have been planted on the plateau De la République; the first 311 yards long and 37 to 76 yards wide, and the other 1,217 yards long by 36 yards wide. The two other screens are along the Grand Tournant, on a very steeply inclined surface, and are 360 and 235 yards long, and 48 to 50 yards wide.

These plantations were begun in March, 1849, and were continued to the end of April, 1851. The trees selected were evergreens of various kinds, such as spruces, European and American silver fir, larico pine, &c., and the larch, set about a yard apart. When planted, they were from 20 inches to 4 feet in height; the smaller ones forming the first row along the roadside and the larger being placed a little farther back. They were all planted with the ball of earth adhering to their roots, and were delivered the next day after they were taken from the nurseries, being supplied by M. Sénéclauze, nurseryman at Bourg-Argental, who undertook the contract for planting. The area planted was a little less than 15 acres, and the cost amounted to 37,174½ francs, or about 2,478 francs per acre, divided as follows:

		Francs.
Purchase of land		14,381 83
1,171½ meters of excavation for planting, at 1.144 franc	1,239 42	
42,380 trees, at 0.455 franc	19,282 90	
1,767 trees broken by the snow, at 0.455 franc	803 98	
32,227 guardian trees (*tuteurs*), at 0.455 franc	1,466 32	
		22,792 63
Total		37,174 45

These plantations were scarcely finished when the result surpassed the hopes that had been formed, and the very first year the snow was retained by the young fir trees so that it did not drift the road that was to be protected. Since then, the movement of the winds has been more and more interrupted, and in proportional degree the expense of opening the road has been reduced, so that it is now quite easy to keep it open for travel through the worst seasons. The trees are now growing very vigorously, and some had increased more than a yard in height in 1858, completely assuring a dense massive growth in the future. Each of the tracts planted is surrounded by a deep ditch, the soil from which was thrown inward toward the trees, to prevent cattle from reaching them.

Had it been practicable to plant each piece of ground with younger trees the cost would have been much less, but the effect would not have been immediate, nor the result so conclusive; and we may now safely affirm, that there is no locality where it is not possible to prevent the drifting of snows along the roads by means of plantations of trees properly placed, and at a cost seldom exceeding 20 francs per meter, linear measure.

If, however, it was necessary to protect a greater length of road, it would be profitable to proceed more economically, by planting younger trees, that is to say, pines and larches at two, and firs and spruces at three years of age. The effect would be felt some years later, but the success would not be less certain, and in this case the relative cost of planting would not exceed 150 francs the hectare (60 francs per acre), divided as follows: 10,000 trees at 0f.01 per hectare, 100 francs; planting at 0f.005 each, 50 francs.

To this we must add the price of the land, which would vary according to the locality.

Success in such labors will depend chiefly upon the choice of resinous species of trees that it may be convenient to plant at the given place, and upon the care bestowed upon the setting of the young trees. From this it may not be improper to enter somewhat into details.

The resinous trees especially thrive upon high, bleak, and rugged mountains; the *Pinus sylvestris*, upon soils of every kind; the larico pine, on exposed slopes, facing the west and south; the maritime pine, on the sands and alluvial soils of low grounds; and the Weymouth pine, on deep, loose soil, and with an exposure toward the southwest.

The firs thrive upon the highest mountains, in a deep, fresh soil, and on slopes exposed to the north and west. The spruce is very easy to plant, as its multiplied and fibrous roots facilitate its hold from the height of 6 inches to 10 feet. The larch should be planted in ground loosely broken and of sufficient depth, at a distance from trees of different kind, and with a southern aspect. As for the cedars, few grounds agree with them, and an eastern exposure sheltered from the north should be preferred; as also a deep soil, rather dry than otherwise. They are difficult to make live; and regard should be had to the nature of their roots, which are long, brittle, and but little branched.

The method of planting would vary according to the size of the trees. When the height exceeds 20 inches, the holes should be a foot square and 15 inches deep; the soil taken out should be thrown one side by itself, the tree with its ball of earth placed and surrounded up to the crown of the root with mellow soil finely broken, and the turf taken from each hole returned to its place at the foot of the tree; so that it may maintain a certain freshness around the roots. If sods are wanting, we may use flat stones for this purpose, which answer the same end.

Trees from 3 to 5 years old may be planted quite economically by two good laborers working together; one making the hole with a square pointed pick and deepening it with a pointed one, while the other at once plants the tree while the soil is still damp. The trees should be carried in a covered pannier, and kept from the action of the sun and air. The workman who does the planting carries a short-handled spade, with which he empties the hole. He then places the tree, spreading the roots in every direction, and taking the greatest care that none of them are broken off. They are then covered with fresh, mellow soil, and the operation is finished by carefully pressing the soil against the tree with the foot, or the handle of the pick. Two skillful workmen will plant from 500 to 1,000 trees in a day. Resinous trees should, from their nature, be planted not more than a meter apart, so as to mutually protect one another; and it will be easy to take out the smaller ones to facilitate the growth of the larger.

In conclusion, the planting of evergreen trees, with an intelligent understanding of condition and requirements, will prevent the drifting of snows, and the large expenses necessary for keeping the roads open for travel during the winter season. We cannot doubt of success, if we choose the kinds of trees most suitable for the soil, aspect, and exposure in which they will be placed. The experience gained within the last few years along the imperial road No. 82, with points of elevation ranging from 900 to 1,200 meters (2,952 to 3,676 feet) above sea-level, leaves no chance for doubt in this regard, and gave, the very first year, the most satisfactory results.

It follows from this, that plantations of trees would be equally useful along railroads, replacing the movable screens that are placed in winter along deep cuts and in places particularly exposed to the drifting of snows.

SANITARY BENEFITS RESULTING FROM TREE-PLANTING.

A circumstance has been noticed at Palo, a railroad station between Civita-Vecchia and Rome, which tends to show the effect of forests upon the public health. For many years a piece of woods had stood between

this place and a malarious district to the south, and while this remained the place was healthy. This was cut down, and presently the south winds brought in the fevers from the pestilential district. Manziana, a place lately almost wholly free from malaria, has suffered in like manner since the shepherds have set fire to an olive forest adjacent. A similar phenomenon was observed at Sezzé. At Supino the arrondissement of Frosinone formerly passed for healthy, but since the cutting off of a piece of woods the malaria soon became seated, and, in a little time, many of the inhabitants fell victims to disease.[1]

Lancisci relates that the insalubrity of Rome was notably increased in the days of Gregory XIII, when a pine forest to the south was cut down because infested by brigands.

On the other hand, cases are not wanting to prove the happy effect of planting trees. One of the most striking of these is that of the Abbey of Trois-Fontaines, near Rome, which passed for some time before, as one of the most insalubrious and fever-breeding places in all the campagna of Rome, but which for the last three years has enjoyed some relief from a young plantation of the *Eucalyptus*; and the success which has followed this experiment will doubtless lead to further planting, and, perhaps, to the restoration of a region hitherto notoriously unhealthy to its ancient salubrity. Examples of success in counteracting the pestilential emanations from marshes by planting this tree are also reported from Algeria. It is supposed to operate partly by absorbing humidity from the soil, and partly through the camphorated exhalations from its leaves, purifying the atmosphere to their leeward. The miasms appear to be condensed by filtering through the foliage of trees, while the oxygen, liberated by the leaves, contributes still further to purify the air.[1] The direct and incidental benefits, in a sanitary point of view, that are derived from the presence and proper distribution of woodlands cannot be considered in detail in this connection.

RAINS.

As has been already remarked, the extent and distribution of our original forests was largely dependent upon the amount of rain-fall and its due proportion in the several seasons of the year. There is no part of the country unfavorable to forest-growth, where these essential conditions exist in proper degree; although from other causes, as, for example, annual running fires, a region may not have borne trees within our recent historic period.

From records, kept through more than 60 years at military posts—observations at academies and colleges, and by voluntary observers under instructions from the Smithsonian Institution, and more recently from records made by specially qualified observers under the Weather Signal Service of the War Department, we are enabled to judge as to what this distribution of the rain-fall now is, and in some instances what it has been through a long series of years.[2] It is proper to notice the fact that the results thus far obtained do *not* justify the statement that the amount of rain falling annually has varied materially, taking a series of years together, or that, whether forests are present or absent, there is any notable increase or decrease of the general average amount in different years. In fact, this cannot be determined with any degree of precision until these series of records shall have been carried through a very long period.

[1] *Revue des Eaux et Forêts*, 1875, 363.

[2] *L'Igiene della Campagna e citta di Roma*, P. Balestrá. Rome, 1875.

But between the results of single years there is great irregularity, and, as many think from a study of these records, an increasing irregularity, in the amount of annual rain-fall. There can, however, be nothing more certain than that in many places, there is a great and increasing irregularity in the distribution of the rain-fall through the several months and seasons of the year, and a tendency to droughts, floods, and uncertain crops.[1]

These irregularities have suggested to some, the theory of cycles, and various periods of return have been mentioned, but none definitely proved. Among other theories is one that seeks to show a connection between rainy seasons and the frequency of spots on the sun. But we know with certainty only this fact, that from year to year there is the same amount of exposure of oceans, lakes, and other water surfaces to the sun, and that, in all probability, the amount of water raised by evaporation is about the same year by year. The precipitation of this moisture occurs whenever and wherever the air which contains it becomes cooled down to the degree of saturation or below, and while some regions, from their prevailing winds, and their mountains or other circumstances of their conformation, are sure to receive copious and often periodical rain-falls, other regions are less favored by these conditions that insure this result, and the amount of rain varies according as the causes operating to bring about precipitation exist or are wanting. Every cause tending to increase the humidity, or to reduce the temperature, is, so far as it appears, a cause of rain. We think it is sufficiently shown by observations in all countries where forests exist that their presence tends to this effect in greater or less degree, and sometimes in a manner so marked that there can be no mistaking the relation of cause and effect.

Our space will not permit us to present tables showing the distribution of rain-fall in different regions. Extensive series are already published and easily accessible; but unfortunately we have not as yet a single instance in which carefully-conducted experiments have been made to show by actual measurement, by degrees and quantities, the differences that exist in the rain-fall, or in the causes that tend to produce it, within woodland and in the open fields adjacent. Until such stations are established we must depend upon what can be learned from such records in Europe, and upon accidental circumstances that now and then afford facts of unquestionable meaning, for the rest.

As for records of floods no year passes without them, and in some

---

[1] A system of weather records by volunteer observers has been organized in Iowa through the efforts of Dr. Gustavus Hinrichs, professor of Physical Science in the University of Iowa, the central station being at Iowa City. About sixty observers have been secured, and observations are made thrice daily (8 a. m., noon, and 8 p. m.), including temperature, rain-fall, winds, and clouds. For convenience of reference, the State is divided, by township lines 77–78 and 89–90, and range lines 14–15 and 30–31, into 9 districts. The system promises to become one of great practical interest to the State. It has hitherto received no legislative aid, and depends chiefly upon the efforts of the originator.

It is thought that a comparison of records, which extend more or less imperfectly through a period of over thirty years, shows a perceptible change of climate, and more frequent droughts.

The rain-fall shows that in 1876 the lines of equal amount correspond very nearly with those of equal quantity of woodlands, and *that those parts of the State which have a high percentage of forest surface are those that receive the greatest amount of rain-fall.* This coincidence is of the highest practical interest, and it matters but little which fact has precedence as the cause, or which is the effect, so long as their relation remains the same, and one of them is directly under our control.—(*First Annual Report of the Iowa Weather Stations*, p. 50.)

years the amount of life and property destroyed is enormous.[1] The consequences of these floods in other countries, more especially in the Alps and Pyrenees, have been so disastrous, and the causes so apparent, that the governments of France and Switzerland have, in recent years, taken extraordinary care to prevent their recurrence, and with reasonable prospect of entire success. The methods employed to effect this object will be more fully described on a subsequent page.

In comparing the climate of the United States with that of Russia, we find some points of resemblance that deserve notice.[2] The greater part of that country and of Western Siberia belongs to the region of summer rains; yet it is divided into two well-marked zones, with different vegetation—the forest region and the steppes. In the former of these, the most rain falls in July and August, and in the latter in June. In its meteorological relations, the steppe is a region where arborescent vegetation is interrupted, or at least greatly checked, from want of moisture. This want of humidity reveals several distinct characteristics, such as the want of rains in the summer season, extreme dryness of the air, and an arid soil. This latter condition is the most important, because if it could be neutralized either by natural infiltration or by irrigation, we might have trees in the driest country in the world. Less rain falls in summer in the south of France and in a large part of Italy than in Southern Russia; but these countries have no steppes, and the cultivation of trees has there been long regarded as among the surest branches of rural economy. In those countries, however, the autumn is rainy, the fall of rain averaging 3 to 3½ millimeters a day, so that the deeper strata of the soil imbibe the water, and are able to supply to the roots the moisture evaporated from the leaves, through the long summer droughts.

On the steppes, however, the greatest amount of rain falls in June, as heavy showers, which flow off on the surface, until lost in the ravines. The autumn is dry, and the winter neither long nor snowy. The melting of snows in spring affords but little water. But in Northern and Central Russia the case is different. The annual amount of rain is but a little more than on the steppes, but the snow falls deep, and lies on the ground through five months of the year. When it melts, it sinks deeply into the soil. Besides this, the summers are cooler, and the rains oftener fall in fine, misty, and protracted showers. This explains the great difference between these two zones, although both belonging to the region of summer rains.

It is moreover impossible to trace with exactness the boundaries of the steppes. The forests begin to disappear on exposed southern slopes, in elevated regions, and where the soil is dry; then the forests will appear only along the rivers; and at last the trees will be found only in locations where there is a natural infiltration, or irrigation.

Along the Baltic we have a belt of autumnal rains and heavy forest growth. In the Ural Mountains there is less exposure to severe droughts, but farther south we find a zone of June maximum, and in its principal features the distribution of the rains follows the following order: After

[1] A memorable flood in the Genesee River, New York, began March 16, 1865, and caused by the rapid melting of deep snows in the hills around its upper waters, by warm winds and rains, is estimated to have caused a loss of not less than $1,000,000 in the city of Rochester, and some estimates fix the loss at three times this amount. Had these snows been reasonably sheltered by woodlands, it is quite certain that they would have melted more slowly and probably without injurious results.

[2] The facts in this statement, so far as they relate to Russia, are condensed from an article by A. Wojeikof, in the *Repertorium für Meteorologie*, published by the Imperial Academy of Sciences, St. Petersburg (1870), vol. 1, part 2, p. 187.

the maximum of June, we find a regular decrease to September, and then again a second maximum in November, differing but a little from October. From August to October the prevailing winds are east, and in the month of November they become southerly, bringing an increase in the amount of rain-fall. After considering in detail the observations made through a series of years, and many cases of exceptional droughts, the author remarks that there appear grounds for believing that there has been within the time observed a perceptible change of climate, more especially in the diminution of the rain-fall.

It is well known that the amount of forest area has diminished very considerably within this period, and it is fair to connect the two coincident facts as cause and effect. Admitting this, the conclusion follows, that with increasing forest area, there would be a decrease of drought, inversely proportioned to its amount.

RETENTION OF SNOWS IN WINTER AND EARLY SPRING.

The effect of woodlands in retaining the snows where they fall, and in delaying their melting in the spring, has been everywhere observed in snowy countries. In such localities the snow cannot be drifted by the winds, and when it melts it disappears slowly, sinking into the soil, rather than flowing off upon the surface. The effect of this delay in checking a too early appearance of fruit-blossoms cannot be mistaken. The result is in fact quite similar to that of considerable areas of water, such as our Northern Lakes, along the borders of which, and especially on the lee-side, fruits are found to flourish with the greatest success. In a country interspersed with clumps and belts of woodlands the snows drift less, and their melting more evenly over the surface cannot fail of being beneficial to the interests of agriculture, and more especially to meadows and pastures.

It is observed throughout the mountains of Colorado, and the territories to the north and south of that State, that the north slopes are, as a general rule, much more heavily timbered than those that face toward the south. This is apparently due to the fact that the winter snows are there detained the longest, and that the soil is by this means kept moist and sheltered, while under the exposure of the sun's direct rays the soil becomes dry and sterile. To this rule there are, we believe, but few exceptions, unless due to a local circumstance affecting the conditions over a limited area. The effect may be partly due to the shelter thus afforded against drying southwest winds.

The Commissioner of the General Land Office, in his report for 1874–'75, in noticing the effect of excessive and improvident clearing upon the mountainous regions of California, and its effect upon the snows and the rain-fall, says:

> Under this state of things timber has, in many instances, wholly disappeared for miles in the vicinity of the large mining centers. Incidentally to this general waste is another result, often disastrous in immediate effects and threatening in future consequences. The mountain-streams, whose steady flow is important alike to the miner and to the agricultural interests of the valleys and plains below, are fed by the melting snows. The steadiness of the flow of these streams—the preservation of their volume throughout the year—so long as natural conditions prevail, is in a great measure due to the fact that over large areas of the higher levels the rapid melting of the winter's accumulation is prevented by the dense shade of the forests. This removed, destructive floods, in the season of returning warmth, to be followed later by scarcity, become the rule. It may be noted also, as another incident to this total destruction of timber along the cañons, that *snow-slides* are of frequent occurrence in the denuded localities of the mining settlements, and that, during the past winter, some were attended with serious loss of life and property.

Some gardeners in the Northern States have a sensible way of retarding the tendency to early spring growth in trees that would be otherwise liable to injury from late spring-frosts by packing snow around a tree, and covering it with sawdust, straw, or leaves. This keeps back vegetation till the danger is over, and delicate exotic trees, not quite hardy enough while young to endure the climate, may be thus accustomed to their location until sufficiently hardy to live alone. It is a practice. of course, limited to ornamental and orchard planting, as a forest-tree that cannot survive without this help might better be given up.

NATURAL DRAINAGE FOLLOWING THE CLEARING OFF OF WOODLANDS.

A cause of desiccation is sometimes observed to operate in a light gravely soil, after the woodlands have been cut off, which cannot be included in the class ascribed to climatic changes. It often happens that small perennial streams, having their beds kept up nearly level with the surface by the obstruction of roots and fallen timber, begin to deepen their channels by the action of the current as soon as these obstacles are removed. As a consequence, the land adjacent becomes drained, and soil, before considered damp and even marshy, may become dry and even arid. The most effectual remedy in such cases, where they become inconvenient, would be to set willows abundantly along the banks and near the bottom of the channel, by which obstructions would be created, and the drainage, with proper attention, kept at such depth as might prove most beneficial to the soil.

INFLUENCE OF WOODLANDS UPON SPRINGS, RIVERS, AND STREAMS, AND IN CAUSING DROUGHTS.

It is a matter of common remark, that our streams diminish as the woodlands are cleared away, so as to materially injure the manufacturing interests depending upon hydraulic power, and to require new sources of supply for our State canals, and for the use of cities and large towns. Many streams once navigable are now entirely worthless for this use.

The mode in which this influence operates will be readily understood, when we consider the effect of forests upon the humidity and the temperature of the air.

A deciduous tree, during the season when in foliage, is constantly drawing from the earth and giving off from its leaves a considerable amount of moisture, and in some cases this amount is very great. This change of state, from a fluid to a gaseous condition, is a cooling process, and the air near the surface, being screened from the sun and from the winds, becomes by this means so humid, that a rank succulent vegetation often springs up and thrives, which in an open field would wither and perish in an hour. The air, being thus charged with moisture and cooled, does not take up by evaporation the rains which fall, and the soil, being more open, readily allows the water from melting snows and from showers to sink into the earth, from whence a portion appears in springs and in the swamps, which give rise to rills and streams.

The air at all times holds more or less watery vapor in suspension, and its capacity for doing so is increased as the temperature is raised, not by a steadily-gaining rate, but more rapidly as the heat is increased, as is more fully shown on a preceding page of this report. There can be no evaporation when the air is saturated with moisture, and no deposit of water in any form until the temperature is reduced to the point of saturation. It is not yet determined as to how far the cooling and

moistening influence of a grove may extend. It must depend upon many circumstances, and especially upon the slope of the surface and the direction of the winds. The effect is often apparent to the eye from the freshness of the herbage in adjacent fields for many rods in width.

In noticing the influence of forests upon the humidity of the air within them, it is found that the coniferæ differ greatly from the broad-leaved deciduous species, the former being drier than the latter; and that where a forest-growth has changed from the latter to the former, the same soil will be drier than before. Some have ascribed this to a difference in the amount of rain retained or of evaporation given off by the foliage; but a more probable reason may be found in the fact that the soil in woods of the coniferous class is more exposed to the sun,[1] and that the surface-evaporation is therefore more active. The mat of dead foliage is more pervious, allowing the air to permeate and evaporation to go on. The tops of the trees of this class are less uniform in height, and are therefore more exposed to the winds, which also tends to more evaporation.

It is found by careful observation, that different kinds of timbers possess very unequal powers for the absorption of water from the soil during the active season of vegetation, and that it is generally in inverse proportion to the density of the wood. We know that the leaf-surface of a tree is in direct relation with the amount of wood formed, and that the evaporation from leaves is greater when their tisues are lax and moist, implying a larger amount of water in circulation and greater absorption from the roots. The greater drying-powers of the resinous species has been attributed to the demands made by the latter in the formation of resin. The abundance in which this secretion is formed by the maritime pine growing in damp soil behind the littoral dunes of the coast, has been noticed as proportional to its power of drying the soil.[2]

The tall grass and other herbaceous covering of the western prairies, in a state of nature, answered in some degree instead of forests in maintaining the humidity of the climate. The summer rains were certainly more uniform and abundant than now, and the streams were higher in summer. But as pasturage and cultivation have removed this protection, we are everywhere beginning to feel the consequences, and nothing short of establishing some shelter from the sun and drying winds, will save the country from increasing aridity. The excessive rains and consequent damage from floods, and delays to agricultural operations during the early part of the summer of 1877, throughout

[1] The leaves of the *Eucalyptus*, of Australia, in their mature state, present their edges to the sky, and therefore cast but little shade. Should this tree hereafter be extensively grown in California or elsewhere in the United States, we would doubtless find the soil in such woods much drier than in woodlands of other kinds.

[2] The following table shows the drying-power of different kinds of trees, as calculated by M. Burger:

Quantity of water required to supply, daily, a cubic meter of standing timber between April 15 and October 15.

	Cubic meters.	Liters.		Cubic meters.	Liters.
Oak	0.077	= 77	Alder	0.144	= 144
Birch	0.105	= 105	Poplar	0.155	= 155
Bass-wood	0.125	= 112¼	Pine	0.193	= 193
Cherry	0.116	= 116			

Kansas, Nebraska, and Missouri, are not without precedent. It is remembered, in Central Kansas, that heavy rains occurred in August, 1858, and that destructive floods occurred in June and July, 1867. The season of 1868 was accounted a wet year. It is the general belief of the inhabitants who have resided in that section since the first settlement that the rains are on an increase in recent years.

The dark-colored prairie soil of Kansas and Nebraska, when covered with herbage, is not liable to erosion. Even after it has been broken up, this soil when wet becomes pasty and somewhat impervious to water, in heavy rains, and it is not until the surface has been worn away till it reaches the subsoil, composed of a porous, sandy loam, that these erosions become serious, and, when once formed, difficult to repair.

The absorption, retention, and delivery of water by the soil under cultivation, or covered with forests, has long been a subject of observation, and has necessarily been an element in calculating the capacity of streams for the maintenance of their supply, ever since the subject has been reduced to exact rules. The following observations, nearly a century old, are strictly in accordance with modern experience:

> Countries having a level surface, and those where the soil is generally cultivated, absorb relatively much more water than those where these conditions are different. It is true that after the heaviest rains, bare and uncultivated land will scarcely be damp at a few inches below the surface, while the same soil, when finely divided by cultivation, would be saturated by the water to the depth of several feet. * * * It always takes water some time to penetrate the earth, even when there is nothing to hinder its flow, and every obstacle that tends to obstruct it favors infiltration. Woodlands are therefore well adapted to hinder the waters from running off, and to favor their passage into the soil. This they do with better effect when they are more densely covered. It is, moreover, certain that the leaves of trees, pump up and absorb a large amount of water, and although the soil on which they grow is uncultivated, it is much more susceptible of absorption of rains than bare and uncultivated land.
>
> Forests contribute so effectually to the detention and preservation of the waters that springs in some countries, flowing through the year, have entirely disappeared after the woods had been burned, nor did they reappear until after the verdure had been restored, their existence being closely dependent upon its presence.[1]

Mr. James Brown, of Stirling, Scotland, a standard authority upon forestry, in speaking of the effect of tree-planting upon moisture, says:

> I have frequently been surprised to find (on examining woods which had been planted some 10 or 12 years, all the land under which had been considered dry at the time the plantation was made) wet spots, spreading wider and wider every year, and some of them even beginning to throw out runs of water; thus proving that under the shade of the trees the larger portion of the moisture of the land is retained, and therefore accumulates in spots, according to the nature of the subsoil.[2]

In a study of the influence of forests upon climate and springs of water, by M. Jules Maistre de Villeneuvette, published at Montpelier in 1874,[3] this observer during eighteen months continued his experiments in a wooded basin and in one that had been cleared, but otherwise similar in soil and conditions. The former, with an area of 779 hectares, delivered 110 liters of water very regularly; the other, with 6.786 hectares, had a drainage of only 10 or 12 liters a second, and was very irregular. He found the temperature of the open fields at least 10° (C.) above that in woods. He noticed that in the southern region, the cultivation of cereals is becoming more uncertain and less profitable, and that the injuries by the *Phylloxera* upon the vine-roots were more destructive; and concludes by urging upon his readers the necessity of counteracting this growing tendency to drought by planting and irrigating.

---

[1] *Nouveaux Principes d'Hydraulique.* Par. M. Bernard, 4° (1787), p. 141.
[2] *Forester*, 4th ed., p. 14.
[3] *Influence des Forêts sur les Climats et les Sources*, 8vo, pp. 60.

M. Conte-Grandchamps, engineer of roads and bridges, in an official report of engineering operations for irrigation, which included the question of supply as well as delivery in the department of the Basses Alpes, at an elevation of 1,200 to 2,200 meters above sea-level, has made this subject of the influence of forest a subject of long and careful study, and with these results:

In granitic soils, at 1,000 meters above the sea, the delivery of water by springs is twice as great in wooded regions as in those that have been deforested; and that rewooding, joined with works for storage, may augment by 7 cubic meters daily per hectare rewooded the delivery of springs. Some springs that have failed from deforesting, have reappeared with forest vegetation. He had oftentimes observed in the mountains, that fogs caused true rain in forests of fir, while they left no traces of humidity on the denuded lands.

Mr. R. U. Piper, in his *Trees of America* (Boston, 1855), mentions an illustration of the return of water by restoring the woodland shade, as coming under his own observation:

> Within about one-half mile of my residence there is a pond upon which mills have been standing for a long time, dating back, I believe, to the first settlement of the town. These have been kept in constant operation until within about 20 or 30 years, when the supply of water began to fail. The pond owes its existence to a stream which has its source in the hills which stretch some miles to the south. Within the time mentioned these hills, which were clothed with a dense forest, have been almost entirely stripped of trees; and to the wonder and loss of the mill-owners, the water in the pond has failed, except in the season of freshets, and, what was never heard of before, the stream itself has been entirely dry. Within the last 10 years a new growth of wood has sprung up on most of the land formerly occupied by the old forest, and now the water runs through the year, notwithstanding the droughts of the last few years.

Professor Newberry, in his *Geology of Ohio* (i, 24), mentions a fact which seems to indicate that the Ohio River was extremely low at a period remotely passed, but still within the reach of human history. It is well known that from the drying up of tributaries, the Ohio has been getting lower and lower in dry seasons for many years. About 1871–'72 the waters sank lower than had been known before, and at Smith's Ferry, where the Pennsylvania line crosses, a ledge of rocks was laid bare that had not been seen before by the present inhabitants. On this surface, from 50 to 100 feet and several hundred yards long, inscriptions have been made, such as are ascribed to a race which densely populated the country before the advent of the recent Indian tribes. It is possible to conjecture that the clearing of forests by an agricultural race may have brought about the conditions now existing, a long interval of neglected culture and forest growth having since intervened.

The effects of forest-waste upon rivers were very fully discussed at the International Congress of Land and Forest Culturists, in their session at Vienna, in September, 1873, and startling facts bearing on the subject were presented. Instances were cited showing that, in consequence of clearings, there has been a gradual decrease in the depth of the large streams of all countries. In some cases rivers, which in former times had been of considerable magnitude, had entirely disappeared. The Rhine, the Elbe, and the Oder are all shallower now than in the past. It was asserted that the depth of the Elbe at Altenbrücke, in Hanover, in 1787, was 48 feet at low water. In 1812 it had decreased to 46 feet 6 inches; and in 1837 a further reduction to 38 feet was indicated, making a diminution of 10 feet in half a century. The Elbe rises in Bohemia, where, until recently, the forests were under no control, and so were destroyed in the most random manner. The Rhine, also, has

far less water than formerly. Its sources are in Switzerland, where, perpaps, more than in any other country in Europe, the woods have been considered common property, and the uprooting has been carried on in the most reckless way.[1]

Dr. Lindley, in a leading article in the *Gardner's Chronicle* (April 2, 1859), says that the effect of felling large quantities of timber in diminishing atmospheric moisture is notorious. To say nothing of the altered climate of these islands consequent upon the removal of our superfluous ancient forests, there are other and more recent cases which may be safely quoted:

On the 27th February, 1856, the subject was brought before the Chamber of Deputies by M. Ladoucette, deputy for the Moselle, who adduced numerous modern instances of humid countries having become arid in consequence of the immoderate clearing of forests. He cited Fonteney and Provence as places where it had led notoriously to wells and pits becoming dry, and called as evidence to the same effect the prefect of the Haute-Garonne, who asserted that in the whole of the Eastern Pyrenees and the Hérault, the destruction of timber had been calamitous. The temperature became higher, wells and water-courses diminished, while the dryness of the climate was greatly increased. Similar evidence was collected by Professor Laurent, of Nancy, of whose numerous statements the following may be taken as specimens:

After referring to the desolation brought upon so many nations of the East by the loss of their forests—upon Babylon and Nineveh, Thebes, Memphis, Carthage, Palestine, and the Troad—he concludes by quoting similar examples in the recent history of France. In the Vosges the destruction of forests has gone too far, so that the humid vapors, so necessary to plants, have diminished, while the soil has become arid and inundations frequent.

In the department of the Gard it did not rain in 1837 for nine months. Such a dryness was not in the memory of man. The people ascribed it to the successive destruction of the mountain-forests. The town of Nismes, whose name is derived from the forests that surround it, exhibits little except sterile wastes. At Berjiers, three hundred members of the agricultural society reported in 1797 that the vast forest which once sheltered that place having disappeared, the loss of the olive-crop is the inevitable consequence.

The authorities of the Isère represented in 1793 that the destruction of forests had altered the temperature, augmented dryness, and seriously affected the crops. As to wells and pits, their supply, too, had, before 1838, been most seriously diminished.[2] Violent storms and torrents of rain, indeed, fell from time to time, but they ran off the land without soaking into it, and the subterranean reservoirs gained nothing. In short, ancient mill-streams were gone, or flowed only in winter; and the old head-waters of the river affluents had disappeared in places where the woods had been grubbed up.

An effect which, although local, is not less distinctly attributable to its cause, has been observed of late years along a belt of country adjacent to the river Saint Lawrence, on the northern border of Jefferson County, New York—on the north side of the river in Canada, and upon the Thousand Islands. A considerable part of the surface is there occupied by ridges and low elevations of a reddish gneiss rock. The surface was formerly for the most part shaded by trees and shrubbery that found root in the narrow pockets of soil and little ravines among the rocks. But most of this growth has been cut off, and the surface is now exposed to the full rays of the sun, so that the rocks become heated by day and retain their warmth in the night. It is now observed that the dews are less frequent, and that the currents of air, just reaching the point at which precipitation would take place, become rarefied in passing over these warm surfaces, so that gentle showers dry up as they approach and leave a belt of country distinctly affected by drought, but a few miles

[1] Consul Wisner's communication to Department of State, November, 1873.

[2] General M. R. Patrick, formerly president of the New York State Agricultural Society, in an address made some years since, stated that statistics of the pump-trade show a gradual increase in the length of tubing required. In Central Illinois, this increase in the depth to water in wells had increased about 9 feet within the last ten years.

distant from a region where summer showers are of common occurrence and a drought is not felt. This has been observed for several summers in succession, and will probably continue so long as these conditions remain.

An effect quite similar to the above, is described by the authors of a memorial addressed to the legislature of Maine,[1] upon the necessity of adopting measures for the protection of forests in that State, in which, according to erroneous popular opinion, there exists an abundance of timber for an indefinite period of time.

There is a portion of Hancock County (Maine) along the coast, that is now nearly denuded of trees. During the heat of summer the radiation from the parched surface affects the atmosphere to excessive dryness. The electrical rain-bearing clouds that approach from the westward, as they come within this dry atmosphere, are absorbed and dissipated before their watery contents can reach the earth, while the clouds just north of them float on over a better wooded district and yield copious rainfall; and on the other hand, the showers continue abundant in the more humid atmosphere of the contiguous bays and ocean. The observing seafaring inhabitants of that district, after years of perplexity over the fact and the hidden cause, at last inquired in all seriousness, whether a telegraph wire, located to the north of them, does not unfairly "switch off" the showers that rightfully belong to them.

The commissioners who prepared a report on the disastrous effects of the destruction of forest-trees in Wisconsin (1867) observe that—

In the hot and dry plains of our southwestern territories we often see clouds passing overhead that reserve their contents until they have passed from these almost desert regions. These clouds frequently present all the actual appearance of rain in the higher region of the atmosphere, and the fertile-giving drops are seen to fall far down toward the earth, only to be dissolved and dissipated in the lower strata of the air, heated by the reflection from the parched earth which these rain-drops did not reach.

In 1873 Herr Gustave Wex, councillor of state, and chief director of works undertaken for improving the Danube, published a paper[2] embracing many points of interest, relating to the diminution of water in wells and streams, and the depth of water in rivers, which he ascribed to the clearing off of forests. He presented long series of annual observations made by river-gauges, tending to show that the volume of water has very sensibly decreased in the period covered by these records. In the Rhine at Emmerich, in the years from 1770 to 1835,[3] the mean depth of the first ten years was 11 Prussian feet and 4.1 inches, and in the last ten years 6 feet 9.2 inches. The decrease in the Elbe, the Oder, the Vistula, and the Danube had also been considerable, and apparently from a common cause. In these studies he arrived at the same conclusions as those published some years since by Dr. Berghaus, although some have attempted to explain these differences by ascribing the changes to other causes, such as modification in the river's bed and the like.

With respect to high floods, it appeared evident that these rivers deliver much more water in recent times than in the earlier years. From diagrams that accompany the paper under notice, it is made apparent, that in former times the rise in consecutive years was more uniform, while in later years a very high flood may follow a year of low water. The alternations of wet and dry years are more frequent and irregular, and the extremes of each are greater than were before known. These

---

[1] See *Report Maine Board of Agriculture*, 1869, page 82. This memorial is signed by Calvin Chamberlain, of Foxcroft, and Samuel L. Goodale, of York.

[2] *Ueber die Wasserabnahme in den Quellen, Flüssen und Strömen, bei gleichzeitiger Steigerung der Hochwasser in den Culturländern.* Separate imprint from the "*Zeitschrift des österreichischen Ingenieur- und Architekten-Vereins,*" II., IV., and VI. numbers. 1873. 4to. pp. 41, with 7 plates.

[3] The years 1794, 1795, 1811, and 1812 are not given.

extremes are especially noticed in the tables given for the Elbe and the Vistula. As to the cause, this author remarks:

The reason of this remarkable phenomenon is evidently this, that since many forests have been cut off, more particularly on the mountains, heavy rains and deluging showers occur more frequently; and besides this, the soil being bare of trees the rain penetrates less into the soil and more speedily reaches the streams and rivers, which they fill to overflow; and finally the mass of water tearing rapidly along, erodes the mountain-sides that have been stripped of their forests, and fill up the channels of the brooks and rivers with soil, sand, and rubbish, by which means their beds are raised, and the water-surface is brought to a higher level.

He then considers the evidences of failure of wells and springs, citing various authorities, and ascribing these facts to the same cause. He attributes to forests the faculty of condensing mists and clouds, and in certain conditions the forming of rain, partly by their cooling effect, and the circulation of air which differences of temperature occasion, whereby mists and clouds are formed and they are led to discharge rain. He attributes this not so much to the forests themselves as to the differences between the forests and the open fields by which these movements of the air are produced that result in rain. The electrical influences of forests, by their attraction, are also thought to increase the rainfall. A part of the rains, by remaining upon the leaves, returns to vapor, and is again precipitated as fog, mist, dew, or rain.

The abundance of moisture in the woodlands, the facility with which it percolates through the soil and reduces evaporation, all tend to the maintenance of springs, and consequently of streams and rivers. The drainage of lakelets, ponds, bogs, and marshes, and the cultivation of the soil, all tend to reduce the volume of waters in streams, except as discharged in heavy rains by surface-drainage, with great violence as sweeping torrents and wide-spreading inundations.

This paper has excited much interest, and its author having requested the Imperial Academy of Sciences at Vienna to appoint a commission to examine its facts and statements, it was done, and after several sessions the commission reported their labors at a session held April 23, 1874.[1] After recapitulating the statements of the author, and the conclusions at which he arrives, the commission proceed to notice some of the arguments offered to the contrary from various sources, the principal of which are as follows:

1. The Prussian official, Oberbaurath, *F. Hagen*, from measurements of the Rhine, at Düsseldorf, giving mean and maximum water-level, has noticed very small diminutions (from 2.9 to 1.6 lines a year), which he ascribes to corrections lately made in the stream, which prevent the stoppage of ice, and facilitate the discharge of the high water.

2. Herr *Maas*, Prussian inspector of works of hydrology, from tables running through 143 years, showing the stand of water in the Elbe, at the gauge near Magdeburg, found a considerable decrease in extreme and mean depths (from 17.35½ to 34 inches), which he attributes to changes brought on by constructions lately executed for regulating the stream, which have lowered the bed, by increasing the velocity of the current.

3. It has been presumed that discharge of water at mean and low stages is neutralized by the high water, which occurs oftener of late years than formerly.

The author sustains his views by the following facts:

1. By measurements of the Rhine made at Sonderheim, through a period of 28 years, by Herr Grebenau, showing not only the height of water, but by calculation the amount passing that place, a corresponding decrease in amount is noticed.

2. Observations by the commission for examining the Elbe show a deepening of the stream-bed in its upper portions, and an elevation of the same from sand-deposits in

[1] Vol. LXIX of *Proceedings of Royal Acad. of Sciences*, April, 1874. This commission consisted of Messrs. Fenzl, Jelinck, Von Schröter, Stefan, and Sues, to which Mr. Wex was himself added.

its middle and lower portions, showing that the lowering of the water at Magdeburg cannot be ascribed to the deepening of the channel at that place.

3. That the high water does not compensate for the decrease in the flow at mean and low stages. The author proves from the measurements at Sonderheim, and from others extending through 32 years at a gauge in the Danube at Alt-Orsova, that there has been a decrease in the depth of water in that river at all stages. As for variations in the result of observations in other streams, the author accounts for them by showing that high water often occurs in the tributaries.

The following table from the work of Berghaus shows the difference of level in the Elbe, at Magdeburg, by months, on the general average of half-centuries.

Diminution of the Elbe, at Magdeburg, during one hundred years.

Months.	Mean depth of water by months.		Difference.
	First half-century, 1731–1780.	Second half-century, 1781–1830	
	ft. in.	*ft. in.*	*ft. in.*
January	9 4.02	7 7.34	1 8.68
February	10 1.55	8 7.33	1 6.23
March	11 1.05	9 9.88	1 3.17
April	10 11.01	9 7.81	1 3.17
May	9 5.27	7 8.24	1 9.03
June	8 3.19	6 5.87	1 9.32
July	8 1.64	6 1.01	2 0.63
August	7 7.04	5 9.23	1 9.81
September	7 3.38	5 7.95	1 7.43
October	7 7.12	5 9.74	1 9.38
November	7 11.03	6 0.38	1 10.65
December	9 0.58	6 10.76	2 1.82
Yearly mean	8 10.74	7 2.13	1 8.61

Were these numbers reduced to a diagram, it would be seen that the curve for the *first* half-century would be above and nearly parallel with that for the *second*, a maximum appearing in March and a minimum in September in both cases. The greatest widening apart would be in December, and next to this in August.

In consideration of the facts presented, the commission arrived at the conclusion, that the decrease in the depth of mean and low stages, is due to a diminution in the amount of water moved annually. This decrease points to a lessening in the yield of springs, of which, however, he gives other proofs, derived from the diminution of water in small streams, and in aqueducts and wells.

The Commission also agreed with the author in the conclusion, that the decrease in depth of low water in streams from a failure in the yield of springs and swamps is well founded. The causes of this decrease are—

1. A less amount of watery precipitation per annum, from the clearing and grubbing of forests.
2. An increase in the amount of evaporation from these causes.
3. Changes of the earth's surface, which, instead of retaining the water that falls and allowing it to penetrate the soil, cause it to flow off rapidly, thus causing high water for short periods, often followed by droughts of long duration.

This subject being also brought before the Royal Academy of Sciences at Saint Petersburg, a paper was read January 27, 1876, substantially confirming the opinions above expressed. The commission (consisting of Messrs. von Helmersen and Wild), in the course of this paper remark:

As a warning example, the author cites Palestine, Persia, Greece, Sicily, and Spain, which countries are suffering in consequence of the devastation of their forests. To

this list may be added a portion of Southern Russia, where 150 to 200 years ago there existed large forests, now changed into naked plains, where the hills are without water, and the population is forced to settle in the valleys. We may also mention the Volga and the Dnieper in Southern Russia, where the forests around their sources have been cleared to such an extent that in their middle and lower portions, where these two rivers, so important to the commerce of Russia, pass through a wholly cleared country, the high water reaches points never before attained when the upper forests were standing. Every one knows of the changes made yearly in the beds of these rivers by these floods, and the consequent inconvenience and even danger which these occasion to navigators. The fact is also generally known that the deep gulfs, which in summer and winter are without water, become wild torrents after heavy rains and the melting of snows in spring, carrying with them acres of the finest soil. We believe that these evils would have appeared in less degree if the country adjoining these rivers had not been cleared of its woods.[1]

EVAPORATION—ABSORPTION OF SOILS.[2]

Experiments (other than those already given) made upon the evaporation of plants, and from soil entirely naked and that covered with turf, have led to the following conclusions:

1. That the evaporation from naked soil (most abundant after a rain), diminishes rapidly as the surface becomes dry. The turning and breaking up of the soil increases and prolongs the evaporation; but still its effect is limited to a comparatively moderate depth.

2. That while plants arrest the direct evaporation of the soil, they give rise to a greater amount of loss to the air than naked soil, and especially to a more prolonged evaporation, because their roots reach the water in strata from whence the evaporation proceeds very slowly. This effect is particularly noticed in the trees that retain their fresh appearance during the extremest droughts of our climate, because they draw their supplies from as low as their roots reach.

3. It appears well established that in summer the naked soil—still more, cultivated soil, especially if sandy—lose by evaporation a notably greater amount of moisture than they receive by the rains. For this reason the summer rains, and even the first rains of autumn, do not raise the water of springs and wells, although if excessive they may find a surface-discharge into the channel-ways quickly and in destructive amount. Su h rains must first supply the losses of the soil before their effects are felt in the deeper strata from which wells and springs are fed.

4. In autumn and winter, the evaporation being feeble, and vegetation dormant, or at least languid, almost all of the rains are absorbed by the soil, or delivered in the water-courses. This explains the influence of these rains upon springs and wells, which are at least annually replenished, if not wholly furnished with a perennial supply from the rains of winter. The differences in amount of rains one year with another appear to occasion those oscillations of level observed in great rivers and lakes, which extend through series of years, and are sometimes serious in their effects upon navigation, and upon property along their shores.

5. The cultivation of the soil notably increases its permeability, depending upon the character of the soil, however, for the permanence of this effect. When covered with crops the evaporation is much greater, but still derived from a comparatively small depth, as their roots are feeble as contrasted with those of trees. So long as the grain is green, the evaporation has a cooling effect, as well upon the air as the soil. This effect becomes sensible in meadows covered with grass, and especially when they have been sprinkled by the rain, the evaporation and absorption of heat becomes enormous.

The foliage of trees evaporates less than that of cultivated plants, but the great expansion of surfaces more than compensates for the difference. Their action is moreover more steady and prolonged.

Under woodland shade the air and the soil are generally cool and damp. The air is *cool* from the evaporation, and the soil *damp* because the superficial evaporation is feeble, and because the evaporation of the leaves is drawn from the deeper supplies. An evaporator placed on the ground, in a piece of wood, would therefore give no true idea of the action going on in the forest.

Woods, and perhaps more still, well-sprinkled lawns, have the tendency to render our summers more cool and humid. But if they give more to the air they take more from the soil, and although this coolness and humidity may tend to produce rains, it is rather a restitution than a gain. Nor could the restitution be complete except in an atmosphere perfectly calm, and in the entire absence of winds.

---

[1] *Montagsblatt der St. Petersburger Zeitung*, No. 102, 1876.

[2] Notes by H. Marié Davy, in the *Revue des Eaux et Forêts*, viii (1869), p. 267.

On account of the differences of evaporation, the water received being equal in woods and fields, the latter ought to be more favorable than the former for feeding the deep sources. The obstacles to flow are greater in woods. The gullying effect very small. The soil itself is less dry and less permeable.

Long studies of M. Belgrand, in the basin of the Seine, tend to show that, other things being equal, the *régime* of the waters and the violence and rapidity of freshets, depend more on the nature of the inclinations than upon the covering.

Effects of drought upon vegetation.

The climate of New England was found subject to occasional droughts of great severity from the earliest period of settlement,[1] but none that equaled in severity that of 1854. With the view of learning its effects, a circular was issued by the Massachusetts Board of Agriculture to intelligent men in every town in the State, with specific questions—one of which was: "*What has been the effect of the drought on forest trees?*" The following are conclusions drawn by the secretary of the board from the replies:

Although the trees of the forest had generally made their growth for the year before the drought commenced, yet our returns show that they suffered greatly from its effects; and here we have another proof of its severity. When a drought is prolonged the leafy organs of all vegetables, not finding their usual nourishment, and losing many of their own juices by evaporation, must cease to carry on the processes of life with vigor; in extreme cases they wither and die, and their loss may even cause the death of the plant. In a very dry atmosphere the evaporation from the foliage of trees sometimes has a similar effect. These effects, the falling of the leaves, and the check, to a considerable extent, of the growth of the tree, were observed on shallow soils in all parts of the State, during the hot weather of the last season. One farmer of Worcester County says: "It has retarded their growth and caused their foliage to fall prematurely. The mountain ash seems to have been more seriously affected than any other tree that I have noticed. The leaves were actually dead, and most of them fallen, by the first of September." So in Essex County, an observing farmer writes: "We feel confident that forest trees have suffered to a considerable extent from the drought. In some instances a whole acre looked as if fire had passsd over it. This is not common." In Middlesex County: "The trees on hills having a rocky substratum had the appearance given to a forest when a fire has been in its immediate vicinity, but had not passed directly through it. The leaves turned early, not assuming the usual autumnal tints, but a dingy brown or chocolate color." Another says: "The drought appears to have been very injurious to the walnut in particular; very many of these withered, and probably the coming season will tell a sorry account of the influence of the drought upon trees." The results, so far as they may be inferred from these extracts, cannot now be known.

In considering the remedies possible for alleviation, forest-planting is prominently mentioned (with the usual arguments concerning its effects), the reclaiming of waste land, irrigation, and deep plowing.

ELECTRICAL INFLUENCE OF TREES.

Popular belief attributes to the beech tree immunity from the stroke of lightning. Dr. Samuel L. Mitchill, a well-known and highly-esteemed

[1] The unprecedented drought of 1854 led to researches into the past history of the climate, which in the absence of instrumental records could only be inferred from other accounts that have been preserved during the colonial period. From these it appears that droughts were experienced in 1623, 1639, 1644, 1647, 1648, 1662, 1664, 1666, 1669, 1670, 1672, 1675, 1685 1686, 1692, 1693, 1704, 1705, 1722, 1726, 1728, 1730, 1737, 1738, 1739, 1743, 1746, 1747, 1796, 1805, 1808, 1815, 1818, 1825, 1826, 1841, 1846, 1847, 1848, 1853, and 1854. Some of these were local, and others general and severe, but none so extensive or destructive as the last one of these years, which embraced not only New England, but nearly every part of the Union. The season opened with unusually heavy rains.

The question of change of climate in New England has been discussed by the Hon. John C. Gray, in his *Essays: Agricultural and Literary*, pp. 169–204.

naturalist of his day, in a note to an address before the New York Horticultural Society, August 29, 1826, published some interesting statements upon this point, among which it was said, that the Indians of the western country were accustomed to seek the nearest beech tree for protection during a thunder shower. After some allusion to classical literature to prove a somewhat similar belief among the ancients, with regard to the laurel, he suggests as a practical application that beech groves should be planted near and around dwelling-houses and barns for the immunity of cattle, as well as human beings, from the violence of atmospheric electricity, and that solitary beech trees should be planted here and there over every farm and plantation.

But this is a rule with exceptions,[1] and it is well known that fatal injuries from lightning happen to those that seek the shelter of trees in storm. While there must be a silent discharge of electricity from the points and serratures of leaves, which lessens the probabilities of striking in a forest, it will in some soils and situations be unusually liable,[2] and for this reason, to some extent a protection to lower objects near them. A house surrounded by high trees at no great distance is seldom struck by lightning.

INJURIES FROM HAIL-STORMS.

It is asserted by M. Becquerel, from numerous observations made in France, that hail-storms become more frequent as woodlands are cleared away, and that although such storms may occasionally pass through a forest of small extent, they will sometimes change to rain over a woodland, and again to hail beyond; but oftener they will turn aside, or divide as they come to a large wooded area. This may be accounted for from the fact that the moist air that hangs over a woodland from the evaporation of the leaves becomes a conductor of electricity, and thus lessens the effect of storms.[3]

M. Baille has remarked[4] that zones of hail-storms in France are profoundly modified by local causes, appearing with severity in some districts, and leaving others intact. They have a preference, so to speak, for certain parts of a country, visiting it often, and producing similar effects, observing therein a singular periodicity, returning at intervals of a certain number of days and hours and then disappearing for a series of years, so that periods of two bad years are separated by periods of good years. When they come, they seldom come singly. He cites from a memoir of M. Becquerel, who shows that forests protect the country to a certain extent beyond them, and that belts of hail-storms are

[1] The *New York Tribune* of September 26, 1873, mentions five instances of the beech being struck, giving date, place, and authorities.

[2] Trees in moderately moist ground are but feebly affected, because the electricity of the same name cannot be repelled to a distance in such earth, which is a very bad conductor for large charges of electricity. If the tree, on the contrary, is in ground which is very wet and of great extent, it will be strongly influenced, because the electricity of the same name can pass off to a distance in this good conductor. In fact it will be affected in the greatest possible degree if this good conductor is itself in communication with other sheets of water of indefinite extent. (*Lightning Conductors:* Report of the Commission of the French Academy of Sciences on Lightning Conductors for Powder Magazines; translated by Commander R. Aulick, United States Navy, p. 4.)

Saint Pierre suggested that the planting of trees around habitations would be a security against lightning. (*Botanical Harmonies Delineated*, p. 65.)

[3] The Hon. C. E. Whiting, of Iowa, at a meeting of the Iowa State Horticultural Society in 1870, stated that he had known a severe hail-storm stopped by a grove of trees. (*Report of Iowa State Horticultural Society for* 1869, p. 68.)

[4] *Zones des Orages à Grêle: Discussion des Documents anciens pour dix sept Départements.* Par M. J.- B. Baille. *Atlas Météorologique de l'Observatoire Impérial*, 1866, B. 3.

stopped or turned aside by the presence of a forest of considerable size. He had taken for his data the hail-storms that had fallen during the last thirty years, in a commune where registered by insurance companies with the greatest care, and which, with other records, enabled him to construct charts on a uniform model, and very completely. A small or isolated forest did not have this effect.

In the department of Eure-et-Loire, the forest of Sénouches had proved a protection to a part of the canton of Brezolles. In the north of the department, the storms followed the valley of the Eure until, meeting the forest of Dreux, the storms divided into two parts. In Loiret, on the right bank, the storms meeting the vast forest of Orleans, separate into two parts; one follows the Loire until near the forest of Lorris, which it penetrates by a depression, and seems to wish to unite again with the upper branch, which it sometimes does, but oftener the forest of Montargis prolongs the effect of the forest of Orleans, and keeps the zones separate. The further effects of forests are shown by charts, proving that great woodlands divide and considerably weaken the force of these storms. The branches of the trees are so many lightning-rods, conveying to the ground the electricity of the atmosphere, and neutralize this agency as well as the hail. The forest of Orleans, along the divide of the Loire and the Seine, produces an effect at once clear and decisive. According to Becquerel, the common saying of the country is, that a hail-storm never strikes the forest.

M. Sainjon, engineer, president of the meteorological commission of Loiret, in a further study since published, has confirmed by a series of remarkable facts the observations previously made.

The memoir of M. Baille in a multitude of places presents from records, proving this effect as uniformly seen wherever forests occur of sufficient size to produce these results. These researches are continued in subsequent volumes of the *Atlas Météorologique*, under the editorial care of the astronomer Le Verrier, with continually-recurring evidences of these facts, and illustrations of their effect in series of charts.

EFFECT OF COLORED LIGHT UPON VEGETABLE GROWTH.

On the 18th of December, 1871, M. Bert reported to the French Academy of Sciences the result of experiments under the influence of colored light. Twenty-five species of growing plants, belonging to as many families, were exposed to the same conditions, under colored glass, not receiving the direct light of the sun. The conclusions of his experiments were:

1. That green is almost as destructive as total darkness.
2. That red is very injurious, but not so much so as green, and that it causes plants to elongate in a singular manner.
3. That yellow is less injurious than the above, but more so than blue.
4. That any one of the colors has a bad effect on plants, and that their union in the proportion that forms white light is necessary to vegetable health.

The light that traverses a leaf, when examined by a spectroscope, shows an abundance of green and red rays, which are not utilized by the plant. It is not, therefore, wonderful that young trees will not spring up in the dense shade of the parent tree. But trees differ somewhat in the quality of the light that is absorbed and transmitted, and the mosses and liverworts that enjoy the red rays, will therefore thrive luxuriantly in the densest forest shade. It is highly probable that the reason why the beech will grow under the shade of oak better than the young oak itself, may be due to the fact that some of the rays transmitted by the leaves of the oak are appropriated by the beech.[1]

[1] An interesting observation was made in 1792 by Chancellor Livingston, of New York, with respect to the influence of shade upon vegetation and the differences shown by trees in this respect. He planted a field of corn on the west side of a young wood,

It is remarked that the box-elder (*Negundo aceroides*) does not injure grass and grain by its shade as much as many other species.

The alder is thought to favor rather than injure the growth of grass. The wide-spreading butternut is injurious to both grain and grass to a degree beyond that of most other trees.

It has been remarked that the autumnal beauties of the landscape in a wet season, come on rapidly and soon pass away, the leaves being loosened on the first shower. But in a dry season the coloring is richer and the spectacle more lasting. The splendid hues of the autumnal foliage appear to better advantage upon the hills than in the valleys, probably because the location is drier and the adhesion of the leaves to the tree somewhat greater. It is a well-known fact the American forests present a brilliancy of coloring unknown in Europe, and the fact is equally well established that our climate is much drier. In this we may find the reason for the difference above noticed, and from the same analogy we should expect one landscape to differ from another in the same season, where the soils were different as regards moisture and dryness. This change of color is not due to frost, as some suppose, but to the ripening of the leaves, which will fall in their due time whether touched with frost or not.

FOREIGN EXAMPLES OF THE EFFECTS OF FOREST UPON CLIMATE.

I.—*Climate of the Madeira Islands—illustration of the effect of trees upon the rain-fall.*

These islands, in common with other groups lying in the Atlantic westward from Europe and Africa, have been cited as showing the dependance of rain-fall upon forests. With the view of ascertaining the facts as far as could be known, an inquiry was addressed to the Hon. Jasper Smith, consul for the United States at Funchal, Madeira, who has answered very fully by citing the principal authorities having a bearing upon the subject.[1]

The island was originally covered, as its Portuguese name implies, with a heavy growth of timber. The north part is now sparsely wooded, but the south side is almost wholly denuded, and cultivation is maintained by an extensive and costly system of irrigation. Necessity has in some

---

consisting of oaks, poplars, a few chestnuts, and a large mulberry, the latter somewhat out in the field. The shade at sunrise extended across the whole, but was nearly off by ten o'clock. He observed that the chestnut had a very bad effect. The corn was small and yellow, and the conical shape of the morning shadow could be traced to a considerable extent in the sickly appearance of the plants. The black-oaks were injurious, but not so much so as the chestnut; the poplars very little so, and the mulberry scarcely at all, although its shade remained longer than the others. After considering various suggestions, such as emanations from the trees and the like, he came to the conclusion, which was probably the true one, that certain rays were absorbed more by the leaves of one tree than another; and going beyond this visible effect of transmitted light upon vegetation, he raised the ingenious question as to whether the light thus passed by the foliage might not have some properties that might be applied as a medicinal agent to animal life.

General Schuyler had remarked to him that the black oak was particularly injurious to wheat. The locust tree, on the contrary, was thought extremely beneficial to grass-lands.—(*Transac. of Soc. for Promotion of Ag., Arts, and Manufac.* 2d ed., i, 169.)

[1] Mr. Smith cites "*Madeira, its Climate and Scenery*," by Robert White; "*Climate and Meteorology of Madeira*," by J. A. Mason, and "*Climate and Resources of Madeira*," by Dr. M. C. Graham, as affording detailed information upon this subject. He also consulted Mr. James Yates Johnson, a resident of many years, who had edited a second edition of Mr. White's book. The result was, that reliable information does not exist for a long period back, and that any changes that may have occurred must be inferred from such statements as may be gathered concerning the early conditions. The oldest traces of meteorological records go back 130 years.

cases led to the planting of pines on the hills, but not enough to have a perceptible influence upon the climate. The period when the forests were destroyed is not known, but there is a tradition that a great fire consumed them not long after occupation,[1] and that it smouldered for years before final extinction. We are wholly without knowledge as to the climatic conditions when the island was covered with forests, or as to the changes that the clearing wrought, but simply know that the present conditions have existed for centuries, and probably without material change.

But with respect to the agency of trees in condensing moisture, Dr. Graham remarks:

We may consider the tangible influence of forests in this matter, firstly, with regard to the power of directly augmenting the moisture of a climate; and, secondly, as to the property of absorbing and husbanding water. In this island the great power which trees possess of contributing to the moisture of a country may be well observed upon the mountains. The gentle breezes of the northeast wind almost constantly flow upon the land charged with a certain amount of moisture. During the night the quantity is not large enough to condense into vapor, and the sky therefore remains clear, but in the morning, after several hours of sunshine, the moisture is so augmented, chiefly by evaporation from the seas, as to become visible as mist or cloud at a certain elevation. * * * The moisture of the ordinary breezes in Madeira, augmented as we have seen (I speak from habitual observations), becomes apparent, as a rule, a little way at sea, before it is actually driven upon the mountains, and the mist invests the hills, whether there be trees or not. In approaching the land, the fleecy masses coalesce and augment in size, and at length for a while rest at an interval of eight or ten feet from the hill-side; the interval slowly diminishes, and eventually the mist comes in contact with the soil or leaves of trees. * * * Thus far, in the generation and attraction of mists, trees appear to exert no especial influence, but their power upon mist already formed is great. Where there are no trees the cloud is driven along, depositing little or no moisture, at length to be again completely vaporized over any heated ground and carried away to the sea; but trees largely intercept mist, and the small component vesicles of water coalesce upon the branches, and fall in drops of water upon the earth.[2] This I regard as the principal mode in which trees contribute to the water supply of a country. The mists will form whether there be trees or not, but the water, otherwise lost, is strained out and saved by the forest foliage. I believe the process to be purely mechanical, the mere aggregation of small particles into drops; and, moreover, I have never been able to observe that mist is especially attracted by any particular kind of foliage.

The mist is, at first, apparently dry, but it slowly increases in moisture and density until, if in motion, it forms drops of water upon the leaves. When the mist is stationary little or no deposit occurs. I have watched with much interest for the commencement of the dripping, in reference to the supposed pre-eminence of certain kinds of foliage in the power of condensation. The pine tree invariably begins first, their rough, bush-like clusters of leaves being well adapted to intercept the smallest particles of moisture. The yield of water from this source is very great. The laurels extract water plentifully from mists which are more sensibly damp, and their action in this respect is more important than that of the coniferæ, inasmuch as the dense shade of their broad leaves is subsequently a greater hindrance to the evaporating power of the sun upon the collected water, and the undergrowth is considerable, and highly retentive of moisture.

---

[1] Discovery followed by settlement in 1419.

[2] It was remarked by Saint Pierre, in speaking of the island of Bourbon [Reünion], that the clouds perceptibly deviated from their course to collect around the mountain peaks, from whence they descended into the valleys along the declivities of the forests, which likewise attracted them, and there dissolve in rain, frequently forming rainbows on the verdure of the trees. He noticed that fields situated in an open place in their vicinity very often suffered from want of rain, whereas it rains almost the whole year round in the woods which are not above a gunshot distance. It was by the destruction of a part of the trees that clothed the heights of the island that most of the brooks which watered it were dried up, and now nothing remained but the empty channels. He attributed the diminution of streams in Europe to the same cause, and, applying the principles of modern physics to the classic legends of antiquity, he adds, "It is neither among the reeds nor in the depth of the valleys that the Naïads conceal their exhaustless urn, as painters represent them, but at the summit of rocks, crowned with woods, and towering to the heavens."—(*Botanical Harmonies Delineated*, by J. H. Bernadin de Saint Pierre, p. 54.)

The important influence which the trees of the laurel tribe exert upon the maintenance of springs of water, is well understood in this country, though the admirable laws which have been devised for their preservation are too much disregarded and contravened. In one of the Canary Islands, the people still show the place where, at the head of a deep valley, stood a fine, solitary til tree, which daily used to strain a large quantity of water from the humid mist conveyed inland by the sea breeze. The tree is mentioned by Cordeyro and subsequent writers, with the customary embellishments of exaggeration and superstition; but both the spring of water and the tree are now gone, and the mists, though they still remain, pass over unstrained of their moisture.

The aggregation of small particles of water from humid mists, then, we may regard as a great source of water in a country like Madeira, where the moisture of the prevailing wind is daily condensed upon the mountains; and such a manner of supply must be common to many countries, although it is often unrecognized.

St. Helena.

This island has been mentioned as affording direct illustration of the connection that exists between forests and rain-fall. When first discovered in 1502, it had heavy forests. The introduction of goats, and other causes, destroyed these woodlands, until the island was almost denuded. The consequences were that in the records of the last century we find accounts of repeated and almost periodical visitations of very severe drought, occasioning various losses to cattle and crops. Toward the end of the last century, however, the governor saw the need of strenuous measures to restore vegetation. Nurseries were established, experienced gardeners sent, and trees from all parts of the world were planted and found to flourish. Prizes were given for the number of trees reared, without regard to their character. The *Pinus pinaster* was sown very extensively, and several plantations of this still exist. The consequences of this were described a few years since, as follows:

For many years past, since the general growth of our trees, we have been preserved from the scourge; and droughts, such as were formerly recorded are now altogether unknown. We have no means, however, of otherwise comparing the rain-fall of the two periods, as no tables, or even estimates of the rain-fall can be had for the earlier dates. Our fall of rain now is equal to that of England, and is spread almost evenly over the year. The showers fall more heavily in two or three months of the year. But this period, though called on this account the rainy season, is in no way to be compared to what is understood by an inter-tropical rainy season.

But since the transfer of the island from the East India Company in 1836 these plantations have been neglected, prizes for cultivation have stopped, and, for the last thirty years at least, a score of trees have been cut down to one planted.[1]

Island of Ascension.

This island, some 7½ miles long and 6 wide, was entirely barren when first occupied in 1815, and so destitute of water that supplies were brought from England and the Cape of Good Hope. According to a report made in 1864, there were 29 acres of furze and shrubbery, and over 27 acres in crops. The rain-fall has increased in proportion to the cultivation, and from 10.18 inches in 1858, was 25.11 in 1863, the increase in vegetation being from 59,402 to 75,557 pounds. It grows forty kinds of trees, where but one tree grew in 1843, owing to want of water. The water supply

[1] *Forests and Moisture*, by John Croumbie Brown (1877), p. 117–125, which gives extracts from correspondence in 1865 from his excellency H. R. Janisch, governor of the island. Other authorities cited are *Beatson's St. Helena*, Emsman's German translation of Foissac's work on Meteorology, in relation to cosmical phenomena (1859), and Blanqui, in a volume entitled *Voyage en Bulgarie* (1843).

is excellent, and the garrison and ships visiting the island are supplied in abundance with vegetables of various kinds.[1]

South Africa.

In South Africa, the most disastrous effects are felt from droughts, and from inundations following sudden and heavy falls of rain. It appears from evidence that these conditions have changed greatly within the historic period, and that they tend to grow worse from year to year. This subject has been very fully discussed by the Rev. J. C. Brown, formerly colonial botanist,[2] who arrives at the conclusion that this aridity has been promoted by the destruction of vegetation, removing an important screen which throws off or absorbs the direct rays of the sun, and one which in other ways conserves the humidity of the soil and of the atmosphere. He urges a discontinuance of burning over the surface; the adoption of enlightened measures for the conservation and extension of forests; the construction of reservoirs for retaining the excessively abundant waters after heavy rains; and the using of these waters for purposes of irrigation. The fall of rain in torrents instead of drizzling showers, and its drainage from the surface by short-lived floods instead of equably flowing streams, he regards as characteristics of lands divested or devoid of vegetation, and hence any measures tending to cover the surface with trees or herbage must be followed by good results.

Since the publication of the work above cited, more recent damages, not mentioned therein, have occurred in South Africa from these causes. Toward the close of 1874, according to colonial newspapers, damages occurred from floods which could not be estimated at less than £300,000, and from one report the injury to public works alone was estimated at £350,000.[3]

Mauritius.

Attention has of late years been called to the climatic conditions of the island of Mauritius, following the clearing off of forests, that deserve notice in this connection. This island lies in the torrid zone, exposed to the trade winds of the Indian Ocean, and has an area of about 720 square miles. It was originally covered with dense forests, but the cultivation of the sugar-cane being found extremely profitable, extensive clearings have been made since 1851, resulting in changes that have excited grave apprehensions, and have led to careful inquiries. A government observatory has existed for a long period, but several changes of location render comparisons uncertain. These records, so far as they can be used, show that the absolute and relative humidity, as well as

---

[1] Brown's *Forests and Moisture* (1877), pp. 128–143.

[2] *Hydrology of South Africa; or Details of the former hydrographic condition of the Cape of Good Hope, and of Causes of its present Aridity.* London, 1875, 8 vo., p. 260.

[3] In a more recent work by Mr. Brown (*Forests and Moisture*, 1877, p. 148), a striking illustration of the local effect of trees is mentioned, from a correspondence had in 1864–'65. "This season has been unusually hot and dry along the coast, and all around Grahamtown we have been unable to grow anything all this summer for want of rain. The springs are all failing. You may, perhaps, know the place of Mr. J. J. Stone, on the top of the hill on the Cowie Road, toward the sea, marked out by a quantity of gum trees, on the ridge of the high hills to the southeast of Grahamtown. Well, all through the summer we had only light, misty rain, just enough to dampen the grass, and not enough to wet the ground; but these trees of Mr. Stone's have there converted the mist into rain. They have scarcely felt any effects of dry weather; the vegetables and flowers have there grown all the summer without watering; there the tanks have always been full; and that is the only place of which I have heard, that it has been so within five and twenty miles of Grahamtown."

the rain-fall, have passed through considerable ranges of annual variations, and, as is thought, with a tendency to periodicity.

The forests that have been cut since 1853 are from 8 to 20 miles distant from the observatory, and therefore the influence they may have had, is not directly shown by its records. Mr. Charles Meldrum, the director, in a letter dated August 16, 1877, informs us as follows:

The general belief, in which I agree, is that the humidity has considerably diminished in the interior of the island, and probably the frequency of the rain-fall; but observations have not been taken for a long enough period to enable us to arrive at a satisfactory conclusion as to the rate and amount of decrease. The local government have lately commenced to replant some of the denuded localities, and in the course of time the effect with regard to humidity will be known.

I have little doubt that the destruction of the forests has produced serious effects as to the sanitary and agricultural condition of the island. There have always been lakes and lagoons on the low plains near the coast, formed by filtration from the high lands of the interior. Formerly, when the interior was densely wooded, a large portion of the rainwater was retained, and filtration went on gradually, so that even in the dryest years the lagoons received regular supplies of pure water. But now the greater part of the rainwater is carried away to the sea, and hence in dry weather the sun's rays beat down on slimy, fœtid marshes. During torrential rains, also, the low lands are flooded, and much stagnant water and vegetable *débris* is left behind. The consequence is, that an island at one time noted for its salubrity, has become a hot-bed of malaria. During the last ten years the mortality from fever has been very great. It is during the process of evaporation after heavy rains, that the fever becomes epidemic, and only then with a high temperature. There was a severe drought from January to April, 1875, followed by heavy rains in the latter part of April and in May; but no increase of fever took place, apparently because winter had set in before the rains ceased. On the other hand, after a drought which took place in November, December, and January last, followed by torrential rains, fever became general, and it continued to rage through March, April, and May.

Within the last 15 years many sugar plantations near the coast, in the leeward districts, have been abandoned, mainly, it is said, through want of sufficient rain and moisture.[1]

It is more than a century since anxieties were first felt in Mauritius in relation to the cutting off of forests, and regulations were made with a view of conservation. On the 15th of November, 1769, the governor and intendant—Desroches and Poivre—established a regulation founded upon public policy and private interest, as well to protect the harvests against the violence of the winds as to afford shelter from the burning heat of the sun and exemption from drought. It was declared an important object of the administration, not only to protect the woodlands in the places where they already existed, but to cause plantations to be made in places where they had been destroyed. The measures then proposed may be summarized as follows:

The use of stone instead of wood in building.

Forbidding the carrying of firebrands in the fields, roads, or woods.

Requiring the owners of lands to get licenses before clearing.

Reservations of one-fourth of the concessions of land for forests, and especially the woods growing upon ridges, bluffs, and hills, requiring the woodlands to be brought up to this proportion by planting.

Forbidding the clearing within ten perches along the banks of streams, except roads and paths for coming to the water, or for passing along the bank, and ordering cleared banks of streams to be planted.

Forbidding the grantees of land along the sea-shore, from cutting any trees on the King's reserves, or on their own land within ten perches, or, if cleared, requiring that such lands should be planted.

Forbidding the cutting of wood for forges or other establishments excepting under the direction of a conservator, who was to reserve for high-forest sixteen young trees per arpent.

---

[1] Brown's *Forests and Moisture* (1877), p. 124, cites other information concerning the climate of Mauritius, confirming the above.

See also N. Pike's *Sub-tropical Rambles in the Land of the Aphanopteryx* (1873), p. 422; Thornton's *History of India; Transactions of the Scottish Meteorological Society*, 1866; *Transactions of the Royal Society of Mauritius*, &c.

Precautions against fires, during the operations of cutting wood.

The reservation of certain valuable kinds, and prohibition against the burning of these woods as fuel except the branches.

Requiring every owner or tenant of woodlands to maintain a watch over the same, and holding him responsible for damages.

Preference given to the proprietor in working and drawing wood bought for the King's service.

Restricting the use for fuel to brush-wood and other kinds declared not fit for construction.

Permitting the inhabitants of Port Louis to take wood for fuel where not declared as reserved (but not for cabinet-making) from certain royal reserves named.

Proprietors cutting woods in regular manner were required to cut close to the ground, and makers of charcoal to have their ovens at a distance from the woods.

Restriction against allowing animals to graze in young woods, and requirements for protecting such woodlands, by surrounding them with some defense.

Requirement for planting trees along the public roads at the expense of the owners of land.

Appropriation of fines declared against owners becoming liable.

In 1767, a kind of tree known as the *bois noire* was introduced from Bengal, and immense plantations were made. It proved extremely serviceable, and grew so abundantly that cuttings could be made triennially. A few years later the *Litsea Chinensis*, known first as the Chinese camphor, and later as *bois d'oiseaux*, and the tree affording the drug known as dragon's blood, were introduced and grew luxuriantly.

Ordinances for the preservation of woodlands appear in the history of the island through many years, and under these, the supplies became abundant. The last of these regulations dates in 1826. The introduction of sugar-cane in recent years again led to extensive clearings, and to the consequences above noticed. It can only be ascertained by inquiries upon the spot, and by aid from records and the memory of old inhabitants, as to whether plantings executed under these ancient regulations had the full effect anticipated, or whether the apprehensions then felt were from anticipated rather than existing injuries to the climate of the colony. If it should be found that increased rain-fall followed increased planting, the authorities of the island have their welfare, in this regard, under their own control, and the world at large will be taught another lesson in national economy.[1]

Ceylon.

The planting of tea and coffee a few years since became an object of active and to some extent a speculative enterprise, the soil and climate being alike adapted to both, and with more profit than any other vegetable products previously grown. This led to the extensive cutting off of forests, to such extent that there was reason to fear that districts hastily cleared under these inducements might be so changed that they could not be permanently occupied when the fertility of the soil had been lowered by a few years' cultivation. Dr. J. D. Hooker, of the Royal Kew Gardens, to whom reports had been sent, in a letter dated May 27, 1873, to the Earl of Kimberley, calling especial attention to the consequences likely to follow this improvidence, says:

It is principally on climatic considerations that the cutting down of forests seems to require government supervision. There is good reason to think that in tropical countries the removal of wood operates effectively in reducing the rain-fall. There can, at any rate, be no doubt that the presence of forests plays a most important part in stor-

[1] The regulations above noticed, and some facts concerning former planting, are given in a pamphlet entitled, *Sur le décroissement des Forêts à l'île Maurice* (1837), containing a memoir by L. Bouton, addressed to the Society of Natural History of Mauritius, September 7, 1837, pp. 20.

ing the rain-fall, and yielding up gradually to the streams a continuous supply of water a thing, I need hardly say, in a hot country, of primary importance. Moreover, the rain is retained by forests on the surface of the ground; it gradually permeates to the subsoil, and so feeds the underground water-bearing strata upon which springs and wells must eventually depend. If the forest is indiscriminately removed, the rain runs off as fast as it falls, and washes away the superficial and fertile soil with it.

The mischief already done in Mauritius and various West India Islands is so widely spread (being in some, indeed, irreparable), and the feeling of the colonists against any interference on the part of the government is apt to be so determined, that I venture to press upon your lordship my own opinion as to the urgency of active steps being taken in the case of an island so beautiful and, at present, so fertile as Ceylon. I have lately received an account of the deterioration of the climate of some of the Leeward Islands, which affords a melancholy confirmation of what I have urged above:

"The contrast between neighboring islands similarly situated is most striking. The sad change which has befallen the smaller ones is, without any doubt, to be ascribed to human agency alone. It is recorded of these that in former times they were clothed with dense forests, and their older inhabitants remembered when the rains were abundant and the hills and all uncultivated places were shaded by extensive groves. The removal of the trees was certainly the cause of the present evil. The opening of the soil to the vertical sun rapidly dries up the moisture, and prevents the rain from sinking to the roots of the plants. The rainy seasons in these climates are not continuous, cloudy days, but successions of sudden showers, with the sun shining hot in the intervals. Without shade upon the surface, the water is rapidly exhaled, and springs and streams diminish."

It is not, however, simply to the restriction of the removal of existing forests that I would venture to direct your lordship's attention, but also to the object, no less important, of making new plantations of forest trees useful for timber and in the arts. Such plantations would serve the double object of retaining the desired humidity and of yielding a revenue to the island.[1]

His Excellency W. H. Gregory, governor of Ceylon, in reporting the forest regulations adopted in that colony (July 31, 1873), mentions that Sir Hudson Lowe, when in Ceylon, imported from Brazil the *Lantana* as an ornamental plant. It is now overspreading the island below a certain elevation, between 2,000 and 3,000 feet. It is stated that the moisture retained in the soil by the dense vegetation of this plant, combined with the humus formed by the decay of its leaves, is already renovating land abandoned and worn out. It was thought by Mr. Thwaites, director of the royal botanical garden at Prérádeniya, Ceylon, that this might be introduced with advantage into the West India Islands, now suffering from the destruction of forests, and thus prepare the soil for a new forest growth. If useful there, why not in Southern California and other warm arid regions of our own country?

WOODLANDS IN WARM CLIMATES—FORESTS IN INDIA.[2]

The question as between the maintenance and removal of forests appears to us to be a question of compensations. Wherever the progress of population requires that every portion of the soil must be made to yield its quota of human food, there the destruction of forests is to be desired, and the disadvantages to which want of wood for social and general purposes may lead must be compensated for, as they doubtless will be, by the ingenuity which is born of necessity. But there are localities in nearly all countries to which the tide of population can never flow, but where the forest can flourish, and where it ought to be maintained. To tropical countries, the preservation of the springs which feed the rivers, on which the fertility of the land and the prosperity of the people are so essentially dependent, is of the greatest importance. These springs rise in the mountain regions, where forests prevail, and it is to such regions that a protective agency should be extended, for there can be but little doubt that the entire

[1] It appears from subsequent correspondence that a pernicious system of cultivation, which consists in clearing off, burning, and cultivating a couple of years, and then leaving for fifteen years until some fertility was restored, has been an important cause of this change of climate.

[2] Extract from a report of a committee of the British Association for the Advancement of Science. Ipswich meeting, 1851, p. 78. This committee consisted of *Dr. Hugh Cleghorn*, Madras Med. Estab.; *Forbes Royle*, King's Coll., Lond.; *R. Baird Smith*, Bengal Engineers, and Capt. *R. Strachey*, Bengal Engineers.

removal of wood leads to the diminution of water. In a single sentence, we would say that where human agencies, whether for subsistence or for health, require the destruction of forests, let them be destroyed; but where neither life nor health is concerned, then let a wise system of preservation be introduced and acted upon.

The planting of such trees as are desirable from the fruit which they afford, or grateful from the shade which they yield, is an act which has been held in high esteem in eastern countries, especially India, from very early times. The eastern appreciation of the luxury of shade led to the banks of the canals constructed by the Mohammedan emperors being planted, and the waysides of the imperial roads being lined with trees of various kinds. In the Sunnud of the Emperor Akbar it is directed "that on both sides of the canal down to Hissar, trees of every description, both for shade and blossom, be planted, so as to make it like the canal under the tree of Paradise; and that the sweet flavor of the rare fruits may reach the mouth of every one, and that from those luxuries a voice may go forth to travelers, calling them to rest in the cities, where their every want will be supplied."[1]

But the planting of trees for timber seems to have been neglected there, as it has been in most other countries, until modern times. This is no doubt owing to self-sown forests being more than sufficient to supply all the wants of man in the earlier states of society. As population and civilization are advanced, such forests are looked upon rather as impediments to agriculture than as sources of wealth, and the means of removing trees are more thought of than the readiest means of propagation, or how they should be treated so as to produce the best timber in the shortest time, and in the fullest quantity that the ground is capable of bearing, and so managed that it may yield some profit, even while the timber is growing.

Australia.

In the reports made of the resources of the colony of Victoria in connection with the Centennial Exhibition at Philadelphia in 1876, the committee upon agricultural products used chiefly as food, and on arboriculture, floriculture, and woods, in speaking of the amount and distribution of rain-fall in that colony, remark:

The growth of timber appears to be much affected by these variations of climate, and although many kinds of forest trees of the same, or nearly the same, varieties are found indifferently in nearly all parts of Victoria, they are of much the largest and thickest growth in localities possessing the most regular rain-fall. This seems to be one of the conditions necessary for their finest development. Great difference of opinion exists as to the wisdom of the course pursued in ringing or stripping bark from trees. There can be no doubt that the quality of the grass is much improved, but it is feared that the rain-fall will be diminished.[2]

Forests near Constantinople.

In a paper on the Water-Supply of Constantinople, read before the Albany Institute, June 4, 1872, by Henry A. Homes, New York State librarian—after noticing that the supplies are obtained by making dams across the mouths of the upper valleys and saving the smallest rills, among the ridges of the Balkan range, some 14 miles from the city, the writer remarks, that the catchment basins receiving this water are of only very limited extent, a very few square miles, and adds:

The sides of the hills are all covered with forests of oak and chestnut, and also far beyond the spots whence any water could flow to the reservoirs. This devoting so large a space to forest wilderness within ten miles of a million of inhabitants is no mystery to the people. It is the result of a custom, and a stringent law enforced for 1,500 years, and not a new discovery. The edicts of the Greek Emperors were very early issued requiring the planting of trees, and forbidding any person other than the

---

[1] *Calcutta Review*, No. 23, 1849, in an article on "Canals of Irrigation in the North-west Provinces of British India."

[2] *Official Record*, &c., Melbourne (1875), p. 21.

authorities to cut down a single tree, and the Turks enforce the same law. There *may* be—there *are* differences of opinion as to the physical laws by which the perpetuation of forests secures rain and preserves moisture, but there is no difference as to the *fact* that in the devastation of the forest on the hill-side the usual and regular flow of water is greatly diminished. * * * No record exists of the destruction of these forests on any occasion except once in 1823, when the Janizaries were destroyed by Sultan Mahmoud. It was a question of life or death, and to drive the remnant of them out of these forests they were set on fire, and miles of trees, hundreds of years old, were consumed, and the fleeing Janizaries were shot.

The flow of waters interrupted by this casualty was restored as the hills became again clothed with trees. This example, so far as relates to the diminution of supply as the sheltering woodlands are cut away, has been often exemplified in cases where a city derived its supply from open brooks, as at Albany, N. Y., where the failure has been quite recently supplied by erecting costly works for pumping water from the Hudson River, instead of adopting the cheaper and more rational remedy of buying the light, sandy lands whose drainage supplied the brooks, and planting them with woods.

Central Asia.

The desolation in eastern countries from neglect of agriculture and improvident clearings has often been cited, and abundant instances are referred to in the admirable work by our countryman, George P. Marsh, entitled *Man and Nature*, and in the later volume of the same, entitled *The Earth as Modified by Human Action.* Without quoting from these, we will simply present an item recently published in the *Revue des Eaux et Forêts* (March, 1876, p. 93), which gives a strong illustration of this kind:

The Khanate of Bucharia presents a striking example of the consequences brought upon a country by clearings. Within a period of 30 years, this was one of the most fertile regions of Central Asia, a country which when well wooded and watered was a terrestrial paradise.[1] But within the last 25 years a mania of clearing has seized upon the inhabitants, and all the great forests have been cut away, and the little that remained was ravaged by fire during a civil war. The consequences were not long in following, and have transformed this country into a kind of arid desert. The water-courses are dried up, and the irrigating canals empty. The moving sands of the desert being no longer restrained by barriers of forests, are every day gaining upon the land, and will finish by transforming it into a desert as desolate as the solitudes that separate it from Khiva.

Central America.

The Ausland gives some curious reports upon the effect produced by the destruction of forests in certain countries in Central America, and

---

[1] Malte-Brun, an author of highest authority in matters relating to geography, in describing this country some 50 years ago, says: "The finest provinces of Tartary remain to be described, being generally known under the name of Great Bucharia. * * * The most noted and fertile of all the provinces is that of Sogd, so named from the river that flows through it. 'For eight days' says Ibn Hankal, 'we may travel in the country of Sogd, and not be out of one delicious garden. On every side, villages, rich cornfields, fruitful orchards, country houses, gardens, meadows, interspersed by rivulets, reservoirs, and canals, present a most lively picture of industry and happiness.' The rich valley of Sogd produces so great an abundance of grapes, melons, pears, and apples, that they were exported to Persia, and even to Hindostan."

M. Malte-Brun, again citing from this eastern geographer, says: "I have often been at Kohendiz, the ancient capital of Bucharia, I have cast my eyes all around, and never have I seen a verdure more fresh or abundant, or of wider extent. This green carpeting mingled in the horizon with the azure of the skies. The simple verdure served as a sort of ornamental offset to the towns contained in it. Numerous country-seats decorated the simplicity of the fields. Hence, I am not surprised that of all the inhabitants of Korasan and Maweralnahr, none attain a more advanced age than those of Bukhara." (*Malte-Brun's Universal Geography*, i, 470.)

especially upon the climate of the city of Guatemala. Since the forests which existed between that place and San José, its port on the Pacific, have disappeared, the inhabitants have been exposed to miasms generated on the coast, and new diseases have appeared. The climate is less uniform, the harvests are less certain, the seasons have become capricious, and storms more terrible. In 1875, snow fell in the city, an event that had not been observed within 50 years. Wood, for construction and for fuel, is very scarce at Guatemala.

Near Sensulipec, in Salvador, they have cut down all the forests to get land for planting indigo, and since this devastation, that place, which had not before felt any storms of violence, has suffered greatly, and much more frequently. They are now planting the *Eucalyptus* in Guatemala to replace the forests and to dry up marshy places. (*Revue des Eaux et Forêts*, June, 1877, p. 264.)

Coast of Nicaragua.

In a volume relating to Panama, Nicaragua, and the Mosquito Shore, by Messrs. Pim and Seemann, published in 1869, in speaking of a small island off the coast of Nicaragua, the authors say:

> The climate is undeniably warm, but the trade-winds for a great portion of the year render it delightfully equable. It is a curious fact in connection with the rain-fall, that during the time when the island was one great cotton plantation, the rainy season fell off from seven to five months, seven months being dry and five wet; but now that trees and undergrowth have once more reduced most of the land to a state of nature, the atmospheric conditions are reversed, and at present, seven months' wet is the rule.[1]

South America.

M. Boussingault, whose researches have done much to promote our knowledge of meteorological science and rural economy, after citing the observations made by Humboldt, and as made long afterward by himself, in the land-locked valley of Aragua, in Venezuela, to show that a lake had been greatly reduced in volume by clearings, and again restored by return of woodlands, cites various authorities to prove similar facts, and arrives at the following conclusions:[2]

1. Extensive clearings diminish the amount of running waters in a given country.
2. It is impossible to determine whether this decrease should be ascribed to a less amount of rain falling annually, or to a greater amount of evaporation of rain-water, or to these effects combined.
3. In countries where no changes occur in the cultivation, the amount of running water does not appear to change.
4. Forests in maintaining the waters, equalize and regulate their flow.
5. Cultivation established in an arid and open country dissipates a part of the running waters.
6. Springs may disappear, in consequence of local clearings, without leading to the inference that the annual amount of rain has diminished.
7. Meteorological data collected in equinoctial regions, tend to show that extensive clearings diminish the amount of rain annually falling.

MEMOIR UPON FORESTS, AND THEIR CLIMATIC INFLUENCE, BY M. A. C. BECQUEREL.[3]

The forests exercise in many ways an influence upon the climate, but to understand this we must define what we understand by *climate.*

---

[1] *Dottings on the Roadside, in Panama, Nicaragua, and Mosquito,* by Bedford Pim, Capt. R. N., and Berthold Seemann, Ph. D., &c., p. 324.

[2] Cited in Becquerel's *Eléments de Physique Terrestre et de Météorologie,* 1847, p. 200.

[3] *Atlas Météorologique de l'Observatoire Impérial,* 1867.

Few scientific observers have given more attention to the study of physical phenomena than the late Antoine C. Becquerel. Among these studies, the effect of forests upon the atmosphere within them, or in their vicinity, and their general influence

The climate of a country, according to M. Humboldt, is the combination of calorific, aqueous, luminous, aerial, electrical, and other phenomena, which fix upon a country a definite meteorological character that may be different from that of another country under the same latitude and with the same geological conditions. According as one or another of these phenomena predominate we call the climate warm, cold, or temperate, dry or humid, calm or windy.

We always regard heat as exercising the greatest influence, and after this the amount of water falling in different seasons of the year, the humidity or dryness of the air, prevailing winds, number and distribution of storms through the year, clearness or cloudiness of the sky, the nature of the soil and the vegetation which covers it, and, according as it is natural or the result of cultivation. The following questions arise for consideration:

1. What is the part that forests play as a shelter against the winds or as a means of retarding the evaporation of rain-water?
2. What influences do the forests exert, through the absorption of their roots or the evaporation of their leaves, in modifying the hygrometrical condition of the surrounding atmosphere?
3. How do they modify the temperatures of a country?
4. Do the forests exercise an influence upon the amount of water falling, and upon the distribution of rains through the year, as well as upon the regulation of running waters and springs?
5. In what manner do they intervene in the preservation of mountains and slopes?
6. Do the forests serve to draw from storm-clouds their electricity, and by thus doing diminish their effects upon the neighboring regions not wooded?
7. What is the nature of the influence that they may be able to exercise upon the public health?

From these questions we may see what questions we must solve before being able to decide as to the influence that the clearing off of woodlands may exercise upon the climate of a country. First of all, we should know the geographical position of the given country, its geological condition, its latitude, its proximity to or distance from the sea, the nature of its soil and subsoil, as whether pervious or impervious, calcareous or argillaceous. All of these embrace elements that we must take into consideration. These questions cannot be solved *a priori*, and, with some exceptions, they demand a particular examination, special study and experiments, without which we run the risk of expressing opinions not in accordance with those of other scientific men who, being placed at another point of view may have taken but a part of the question. We will now proceed to give our proofs:

The action of the forests upon the climate of a country is very complex, for it depends:

(1) On the extent, elevation, and nature of the soil and subsoil;

(2) On the aspect, in its relation to warm or cold, or to damp or dry winds;

---

upon the climate of a country, presented with him an engaging theme of observation, and became the subject of elaborate essays. For more than forty years an active member of the French Academy of Sciences, the *Comptes Rendus* of that body afford evidence of his diligent and approved labors, and a record of their progress. He was, besides, the author of a special work upon the influence of forests upon climate. He died January 18, 1878, in the ninetieth year of his age. The article here given, embodies the ripe experience of a long life devoted to scientific researches, and is an admirable example of logical conclusions drawn from carefully observed facts.

(3) On the age since cutting, and upon the species, as whether of evergreen or deciduous kinds, since the radiating and evaporating power are not the same at all seasons;

(4) As to whether the rainy season comes in summer, autumn, or winter; and

(5) The proximity of pestilential marshes, &c.

Whatever the effect of a forest may be, we may assume that it is proportioned to its extent; for a tree or a clump of trees cannot have as much effect as a great mass of woodland. A single tree indicates by its shadow on the ground near it that its presence is injurious to the cultivation of plants within a certain distance, depending upon its height. The higher a forest grows the greater this shadow extends, and thus the effect is felt within a certain limit in its borders and to some distance beyond.

The height of the trees, (if the forest has a certain density), may afford an obstacle to the winds of greater or less extent, according to the slope of the surface and the relation which this bears to the direction of these winds. It is well understood that the forests do not afford any considerable shelter except against the lower winds, and the obliquity of these must be taken into consideration, as we shall hereafter see. Their density, up to a certain point, supplies the place of a solid mass, as we shall further on more fully show.

The nature of the soil may vary, as follows:

It may be silicio-argillaceous, silicio-calcareous, or argillo-calcareous, and the subsoil may be permeable or impermeable. The effects are very different in these various conditions. We may classify these various conditions of the soil as follows:

Pervious soil { 1. Subsoil pervious.
2. Subsoil impervious.

Impervious soil { 1. Subsoil pervious.
2. Subsoil impervious.

The roots of trees penetrating the soil and the subsoil separate these parts and facilitate the flow of waters that may fall upon the surface, and the older the woods and the greater the number of old reserves the deeper do the roots penetrate into the soil and the easier do the waters pass down. Let us examine the effects of these four divisions of the soil that we have mentioned, upon forest vegetation:

1. With a pervious soil and subsoil, the waters are never stagnant, whether the ground is wooded or not.

2. With a pervious soil and an impervious subsoil, there is a stagnation of waters if in an open country, as in La Brenne and Sologne. In a wooded country, and the subsoil, has not too much depth, the waters drain off easily by means of the roots that traverse it; but if not, they remain stagnant.

3. If the soil is impervious, and the subsoil pervious, it will not agree with certain trees, except the oak.

4. If both soil and subsoil are impervious, it is least of all suited for forest culture; nevertheless there are certain kinds of trees that will live and thrive in these conditions. The roots of trees penetrating into the soil have an effect in modifying the distribution of the waters of a country. MM. Gras and Alphonse Surel, from numerous observations made in the Hautes-Alpes, have explained the manner that forests operate when planted on the slopes of mountains. When the soil on the slope is overgrown by vegetation, first of low plants and then by trees, the roots interlacing among one another form a net-work, which gives

consistence to the soil. The branches covered with leaves, secure it against the force of the rains; the trunks, the shoots, and the brush which cover the ground, oppose multiplied resistances to the currents, which, without this check, would wear gullies into the soil. The effect of vegetation is, therefore, to give more solidity to the ground, and to divide the waters over the whole surface. The soil being divided by the roots and covered by a spongy humus, absorbs a part of the waters, and thus hinders them from running off from the surface. The woods, therefore, serve as a shelter against the rains in a mountainous country.

The action of the forests as a shelter against the winds is not absolute, for these effects depend upon the height at which the wind blows. If this height is less than that of the forest, the wind is stopped at every moment by the trees; it loses its velocity, and if the woodland is of sufficient extent it stops it altogether when it has reached its limit. But when the wind blows at a greater height than the trees, the latter have no effect except upon the lower current, at least if its direction is not declined. Above the reach of the forest the upper mass of air, meeting no obstacle, continues its horizontal course with undiminished velocity. The action of a forest upon the wind is therefore limited as regards the shelter it affords.

Forests may operate in two other ways. When found in the way of a current of air moving with violence, and at the maximum point of saturation with vapor, a part of it penetrates the mass, and a part is turned off by the obstacles that it meets in the passage. The higher portion, if it meets a stratum of cool air, has its vapor precipitated and it falls as rain.

When a current of bad air, laden with pestilential miasms, penetrates a forest of a certain extent, it is wholly deprived of these properties. The effect of this is observed in the Pontine marshes, in which a belt of trees preserve all that is behind them, while the uncovered part is exposed to fevers. The trees, therefore, tame the infected air and deprive it of its miasms. This fact has been shown by M. Rigaud de l'Isle in his treatise on foul atmospheres.[1]

M. Hardy, director of the government nursery at Algiers, has given facts that well illustrate the beneficial influence that trees may exert as a shelter. There exist in Algeria three classes of trees: the first, of deciduous trees, such as the poplars, alders, &c., which grow in the ravines and on the banks of streams; secondly, the agaves, cactuses, and palms; and, thirdly, trees with evergreen leaves, such as olives, caroub-trees, laurels, &c. M. Hardy has noticed that trees of the first group, that are natives, grow more in breadth than in height, with constantly a broad flat top. If it happens that some of them come to a large size and find conditions more favorable for their development, they grow vigorously for a time, when, on coming to the height of the trees around them, the top dries up, and the branches spread only in a horizontal direction. This was seen in some poplars planted at Bouffarich, in the middle of the plain of Mitidja, in humid conditions that left nothing to be desired for this species, yet these trees could not get more than 10 or 12 meters high. We often, however, observed specimens that, nevertheless, did not appear to suffer at the top; but they grew at the base of a steep hill, of which the top was much higher than the trees.

[1] This author was one of the savants who was sent to Rome in 1810 to study the question of drainage of the Pontine marshes. He addressed to the Minister of the Interior an extended report, which was fully discussed in the privy council. The work cited was entitled *Memoires sur les Causes de l'Insalubrité de l'Air*, published in the *Bibliothèque Universelle* (1816–1817).

This inability of vegetation to rise above a certain height, much below that at which the tops of these trees commonly stop gaining in altitude, evidently shows that at an elevation greater or less, there exists a stratum of air where further gain in height is impossible. This effect should be ascribed to the atmospheric currents from the desert, which are hot and dry; and all trees growing in Algeria yield to its influence. Trees of the third group, the cypresses and cedars, brave this influence and grow to a greater height.

The principles we have stated, serve to show the part that forests play as a shelter, and the limits to which this effect extends. We are naturally led to examine and estimate the contradictory opinions expressed by Arago and Gay-Lussac upon the effects of clearing, in the discussions of the commission appointed in 1836 to examine and report upon the 219th article of the *Code Forestier*.[1]

If we cut down a belt of woodland on the sea-coast of Normandy or of Brittany [says M. Arago] these countries would be opened to the west winds, coming tempered from the sea, and we should have a diminution of the winter cold. If such a forest was cleared on the eastern frontier of France, the cold winds from the north would blow stronger, and the winters would be more severe. The destruction of a belt of woodland would in these cases produce directly opposite results.

In principle, Arago was right, but not absolutely, for, from what we have said, these effects depend upon the location of the place where the forests are—their height, and various other causes. M. Gay-Lussac held very different language:

According to my observation up to this time, we have no positive proof that forests of themselves exert an actual influence upon the climate of a large region, or upon particular localities, and that, moreover, they have no influence different from that of other vegetation. We might inquire whether the evaporation of water is the same on a naked soil as on soil covered with vegetation. These questions are so complex, when considered in a climatic point of view, that their solution is very difficult, if not impossible. There is another advantage that I will not deny to wooded areas, in favoring the abundance of springs, and, in fact, in everything that may check the quickness of flow in waters, and permit them to infiltrate slowly into the ground instead of running off in floods, thus favoring water sources. But, still, this advantage which we grant to trees, herbaceous vegetation possesses, perhaps, in higher degree, the numerous close-pressed stalks and fibrous interlaced roots forming a thick and spongy mat that wonderfully checks the movement of the waters and holds them till they escape little by little.

On the other hand, M. Beugnot, reporting from the commission appointed in 1851 to revise, if there were need, the *Code Forèstiere* in whatever related to transitory provisions of the code concerning clearing, has denied, although with less authority than M. M. Gay-Lussac and Arago, the influence that great masses of woodlands may exert upon the climate of a country, as expressed in the following language of his report:

The *Loire Inférieure*, the *Manche*, the *Pas-de-Calais*, the *Nord*, the *Somme*, and the *Maine-et-Loire* are among the least wooded of the departments. Is their climate less salubrious than that of the *Landes*, the *Gironde*, the *Loiret*, the *Cher*, and the *Loire-et-Cher*, which are among the best wooded? "We come," says M. Beugnot, "to the same conclusion, in comparing the different countries of Europe, that the clearing of woods is not injurious to the health of a country."

It is impossible to solve this question without bringing proof, and in considering these several opinions we will not attempt, like their authors, to make general statements, but rather facts drawn from observation, as the only means of coming to a conclusion.

---

[1] This article forbids the clearing of lands by private owners, unless their intention is notified, at least four months beforehand, during which time the forest administration may oppose objections, if they find that the clearing is likely to prove a public injury. (H.)

M. Arago says with reason, that the forests serve as a shelter against winds, but he has not said within what limits; yet the whole question rests there, as we will see. The Alps, by reason of their location and height, shelter certain parts of the Mediterranean coast against the cold north winds, especially such places as Nice and Hyères. This same chain of mountains gives an exceptional clime to Lake Maggiore and Lake Como, and the region about them. Nothing of this would appear, or at least to no great extent, if the Alps were not several thousand meters high. Had they been only common mountains, or only as high as common hills, the case would have been different, for the protected places, as we shall see, depends on the heights of the mountains. Well, the action of the forests composed of trees of the first rank, and not less than 30 to 40 meters high at most, ought not to be different from that of simple hills. Their mass is virtually alike.

On the plains of Orange (says M. de Gasparin)[1] the north winds from over the Mountains of Dauphiny strike the earth at an angle of about 15°,—from which it follows, that a height of 200 meters protects a space 2,160 meters wide, a belt always reserved for the choicest harvests, and that has nothing to fear from the cold. Under such a shelter, the mean temperature of the year is one degree higher, so that oranges come to full maturity in the open air at Ollioules, and at Hyères, while they do not stand the winters of Marseilles; and in like manner they cultivate the olive, which they dare not attempt on the plains of Lombardy.

We will cite another instance, that gives an idea of the extent to which a small height may afford protection. In the valley of the Rhône, where the mistral often blows, a simple hedge 2 meters high will shelter to a distance of 22 metres, which is a limit that should serve as a guide for calculation. It is by means of such shelters, very abundantly grown in this valley, that they are able to cultivate vegetables that could not be raised without this aid.

In the open plains of Provence they raise higher hedges by planting cypress and laurel. All shelters of little elevation preserve wide spaces, when the cold lower winds blow horizontally.

We should not forget to mention the different aspects which the two slopes of the Pyrenees present—on the side of Spain exposed to the south winds, arid—while on the north, toward France, covered with pasturage and a fine vegetation.

The examples that we have cited suffice to show, that the action of forests, even in trees of the first size, is limited, and cannot therefore extend to whole regions of country, as M. Arago has asserted.

M. Gay-Lussac is still less explicit, for he has asked only questions, or has given only *à priori* his answers without proofs. He asks, for example, whether the evaporation of water is the same on a naked soil as on a soil covered with vegetation? He also further affirms, that the influence we attribute to forests in the régime of waters pertains also in high degree to herbaceous vegetation. The solution of these questions requires that we should take into consideration the following facts.

Schubler has proved that all soils do not possess in the same degree the property of absorption.[2] In 100 parts of soil dried at 40° or 50° he found the quantity of water absorbed to be as follows:

Silicious sand	25	Pure clay	70
Gypseous soil	27	Fine calcareous soil	85
Calcareous sand	29	Humus	190
Barren clay	40	Magnesian soil	156
Fertile clay	50	Garden soil	89
Loamy clay	60		

[1] *Cours d'Agriculture,* by Count de Gasparin, i, 196.
[2] *Ib.*, i, 196.

The calcareous and silicious sands are therefore the substances that have the least affinity for water, while humus has the greatest. The state of division in like manner has its influence, as we see in fine calcareous soil.

We cannot separate in this actual case the property of absorption from that of aptitude for drying, which we must take into account in evaporation. Experience proves that 100 parts of water in saturated soil lost in four hours, at 13°.75 of temperature (c), the following proportions:

Silicious sand	88.0	Clayey soil	34.9
Calcareous sand	75.9	Calcareous soil, finely powdered	28.6
Barren clay	52.0	Humus	20.15
Rich clay	45.7		

We see, therefore, that silicious sand is a substance that allows the water to escape most easily, while humus is one that retains it for the longest time. Calcareous sand loses water more easily than silicious sand.

We will further mention the results obtained by experiments of Melloni, relative to the cooling that results in certain substances exposed to nocturnal radiation, and which should be taken into the account:

Substances.	*Relation in cooling effect.*
Plants of close leaves	103
Silicious sands	103
Vegetable soil	92

But the absorbing power being equal to that of emission, we should admit that substances within the same time should warm in the same ratio. Such are the elements that enter into the solution of the question, or rather the questions which M. Gay-Lussac proposes.

When the rain falls upon the soil, the upper strata begin by becoming saturated. Then the excess of water passes to the next lower strata, and they also become saturated, and this continues until the excess above has fully saturated the parts of the soil below.

When the upper bed dries from the evaporation into the air, it retakes from that below what it has lost, and this from the next below until all the water originally absorbed is dissipated.

As for the evaporation, it is manifestly less, all things being equal, on wooded soil, than on a soil covered with turf. On the other hand the Count de Gasparin,[1] who has made some experiments upon this subject, has found, in comparing the evaporation of a surface of water with that of a surface of soil completely saturated, in August, and at a mean temperature of 23 to 26 degrees, the following relations one to the other:

	Evaporation from water.	Evaporation from soil.		Evaporation from water.	Evaporation from soil.
First day	15.0	4.1	Fifth day	11.7	1.3
Second day	13.7	2.5	Sixth day	11.0	1.2
Third day	11.5	1.8	Seventh day	9.4	1.3
Fourth day	12.0	1.3			

The evaporation, therefore, goes on rapidly at first from the soil, and then becomes very slow.

The series of experiments that we report, show that the evaporation should vary considerably according to the nature and physical condition of the soil, a consideration to which we have not had regard. Thus soils covered with low vegetation or with woods, and in which the soil is composed of humus, mingled with sand and lime or clay, absorb more

[1] *Cours d'Agriculture* ii, 114.

water than those which contain no humus, and consequently retain it longer than the latter. These effects vary according to the proportions of the various elements of which the soils are composed. The infiltrations are greater in wooded lands than in those covered with sod. The roots penetrate deeper, and thus facilitate the passage of waters, which would be only stopped by an impervious stratum.

The branches of trees in leaf, not only oppose the evaporation of the water in the soil, but the leaves themselves are constantly yielding a vapor from exhalation, and which tends to reduce the evaporation of waters, so far as the moisture exhaled goes to saturate the air, the infiltration at the same time going on into the soil. Herbaceous plants not in masses, do not produce similar effects; in fact, whoever has been in places partly wooded and partly sodded must have observed after a rain and a rest of some duration, that the sodded grounds were dry while the wooded soil was always damp.

We will now speak of the water absorbed by the roots, and that which is exhaled into the atmosphere.

The roots of trees, as shown by the experiments of Hales, Dutrochet, Mirbel, and Chevreul, absorb a large amount of water charged with various elements constituting the sap. The surplus water is evaporated from the leaves, which are constantly surrounded by a humid atmosphere. The water thus evaporated is drawn not only from the upper strata, but likewise from the deeper layers of the soil into which the roots penetrate, and which supply little or no water to herbaceous vegetation. These lower strata are fed by subterranean sheets of water that often come from a distance. Furthermore, this water remaining in these lower strata, being thus given to the atmosphere, fall again as fog, dew, or rain, and thus increase the quantity of water that the surface of the soil receives from some distance away.

The amount of water absorbed by the roots is so great, that it is practically difficult to make much of it remain near the trees, several reasons for preventing it occurring. The soil in contact with the roots, and for a little distance away, is in a certain state of desiccation, little by little it loses its nutritive properties, the lime, &c., and when these elements are gone, the soil contains little but sand and clay, which then becomes more permeable. It is, therefore, well demonstrated—

(1.) That a difference exists between the evaporation from a naked soil and a soil covered with sod.

(2.) That there is a like difference between a soil covered with sod and one that is wooded, with the further advantage of the latter in facilitating the infiltration of water.

(3.) That the amount of water absorbed by the roots does not produce drought in the soil, since it is returned after evaporation in the condition of fog, dew, or rain. The drought does not take place till the soil is exhausted.

Let us now see to what extent the conclusion of M. Beugnot is well founded, that the clearing of the woods is never injurious to health. This conclusion is true if the soil is siliceous or calcareous, and the subsoil permeable; but it is not if either one or the other of these is argillaceous, because in this the roots are no longer able to facilitate infiltration, as we see in Sologne, la Brenne, and la Dombes, which cannot generally be drained except by drawing off their stagnant waters. It is the same if the woods are cleared in the vicinity of pestilential miasms, as the Pontine Marshes.

Let us now pass to consider the thermal influence of forests. This in-

fluence has been established by Humboldt, and the meteorologists, as follows:

They shelter the soil against the sun's rays; they maintain it in a greater degree of humidity, and facilitate the decomposition of the leaves and litter, which they change into humus; and they act as a cooling cause, by producing active aqueous transpiration from the leaves and by multiplying in the expansion of their branches the surfaces warmed by the solar heat, and the surfaces cooled by nocturnal radiation.[1] In regard to the action last mentioned, positive experiments show that the layer of atmosphere in contact with a meadow, or a field covered with herbage or vegetable leaves, becomes cooled, by nocturnal radiation, other things being equal, several degrees—sometimes as many as 6, 7, or 8 centigrade—below the temperature of the atmosphere at some meters above, while nothing of this kind takes place over a naked soil, which becomes warm or cool according to the nature of its component parts. We will add, as we have demonstrated, that the leaves as well as the trunk and branches become warmed by solar heat, and retain into the night a portion of this acquired heat. This effect should counterbalance the cooling from nocturnal radiation. We have not, thus far, taken account of the fact that the warming of the trees by the sun has a considerable effect upon the temperature of the atmosphere outside of the woods, as well as within them.

To explain the thermal influence of the trees upon the temperature of the air, it will be proper to unite with some old observations others that we have made upon the temperature of the air at different heights, near and at the surface of the trees. Messrs. Humboldt and Bonpland, in sleeping on the grass during the clear tropical nights on the plains of Venezuela and the Lower Orinoco, experienced a damp coolness, while the atmosphere one or two meters above them had a temperature of 26 to 27 degrees of the centigrade scale. Within the equatorial and tropical regions, where the nocturnal radiation operates with the greatest force, by reason of the serene sky, the increase of temperature as we rise above the soil becomes evident, as in the middle latitudes, but in much higher degree. We therefore do not observe in the torrid zone any change in vegetation from sea-level to a height of 600 meters, and from that level to 1,200 meters we still retain the flora of the tropics.

We may now explain why, in our latitudes, certain kinds of cultiva-

---

[1] The effects of radiation of heat from foliage is thus explained by Humboldt:

The leaves of a tree, of course, are in position neither parallel to one another nor horizontal. They present different inclinations. But Leslie and Fourier have shown that the effect of these inclinations on the quantity of heat emitted by radiation, or the radiating power of a surface estimated in one direction, is equal to that which is possessed by a surface perpendicular to that direction. At the commencement of cooling caused by radiation, the leaves forming the highest crest of a tree are the first to lose heat. The next lower layer of leaves, having their upper surfaces facing the under surfaces of the higher leaves, will give out to the latter more heat than they receive back; and the result of this difference of radiation causes the process of cooling to spread until all the leaves of the tree are reduced in temperature. Therefore the refrigerating power of the tree, by radiation alone, depends on the extent of surface of the leaves; so that where the horizontal section of a tree may not contain more than 400 square feet, the effect of its leaves acting in mass will be several thousand times greater than 400 square feet of soil uncovered, or covered only with grass.—(*Asie Centrale*, iii, p. 204.)

Elsewhere in the same work Humboldt, in speaking of the threefold action of forests in cooling the air, by directly shading from the sun, by evaporation from the leaves, and by radiation of heat, remarks, that a knowledge of the extent of forests compared with the surface of the country which is uncovered is a point of the greatest importance in judging of its climatology. The want of forests increases both the heat and dryness of the air; and this dryness, in diminishing the extent of vapor and the vigor of vegetation, reacts in the heat of the climate.—(*Ib.*, iii, p. 199.)

tion cannot be had in valleys while they succeed upon the hills, and the reasons why vegetation may be touched by frost in the low grounds while it is not at higher elevations. M. Martins has noticed a fact of this kind in the botanical garden at Montpelier, where the laurels, figs, and olives perished in all the low grounds in the botanical gardens, while they were spared at some meters of higher level, the conditions as to shelter being just the same, and there being no other differences than altitude. Do we not likewise know that vines growing on the hills yield better wine than those on the flats, and the reasons why they ripen their fruits more completely?

The experiments we have made with the electric thermometer bring the evidence of this fact strongly to light. The temperature of the atmosphere rises from 1m.33 above the ground to 21m.25 at the top of a horse-chestnut tree, and probably to a certain height above, the distance of which limit has been fixed by M. Martins and other meteorologists; for the leafy covering of the trees should have the same effect as the soil covered with low vegetation, by reason of its great absorbing and evaporating power. The mean differences between the temperatures of the two stations have been determined at the Jardin des Plantes, during several years, as follows:

From 1m.33 to 16 meters	0°.420 (C.)
From 16 meters to 21m.25	0°.580

We therefore clearly see the effect which low vegetation and the foliage of trees exert upon the temperature of the ambient air, through the influence of the radiation of heat. We will now inquire as to which it may be, with regard to the body of the trees—that is to say, the trunk and branches. All bodies, and trees the same as other bodies, become cool or warm, according to the air around them, and participate to greater or less extent in the variations of temperature of the ambient air. The effects produced depend on the state of the surface of bodies, its conducting powers, and specific heat. The experiments leading to these results are described in several memoirs which we have presented to the Academy of Sciences,[1] and furnish the most convincing proofs. The following are some of the results observed:

In seeking to find the variations of temperature within a maple of 0m.4 (15¾ inches) in diameter in the midst of a mass of trees, it was found that during the months of August, September, and October the average temperatures did not vary sensibly from that of the air in September, although the range in variation was scarcely half as great within the tree as in the air.

The temperature within the tree was far from being the same in every part. If the leaves and branches put themselves promptly in equilibrium with the temperature of the air, the trunk did not delay to do the same to a depth of 0m.1 (about 4 inches). These effects are different in trees exposed to the sun, and according as these are near to or far from objects that absorb and radiate heat. Near a wall 2 meters thick a plum-tree was growing, 6 meters high and .35 in diameter, and covered with leaves and fruit in July. The difference between maximum and minimum was in some days from 24° to 25° (C.), and the temperature within the tree arose to 37°. Such a condition could not exist long without enfeebling the tree, and as a consequence its leaves perished little by little, its fruits fell, and everything appeared to indicate the approach of death, which came a month later, and was caused by what gardeners call a "*coup de chaleur*" (stroke of heat).

---

[1] *Mémoires de l'Académie des Sciences*, 1861–'64.

We see, therefore, that a tree warms itself in the air, like any inert body, and the more rapidly according as its body is of less volume and its bark of greater absorbing power. It is also true that, having surrounded the trunk of a plum-tree, to the height of 2 meters, with a covering of tinned iron, which has a great reflecting power, the temperature of the air being generally the same as before, the difference between the maximum and the minimum went down from 13°.07 to 5°.2 (C). We see from this that the temperature of the plum-tree had become more uniform. Upon taking off this covering the difference between maximum and minimum increased, and became as great as before. Coverings of metals, or of straw, diminish the variations of temperature within the tree, and render the changes of heat more regular, and we may conceive that the nature and thickness of the bark ought to exercise a great influence upon the warming of trees. Some experiments made upon the *Opuntia*, and other plants, tend to show that the leaves and small branches speedily acquire the temperatures of the surrounding air.

Upon comparing the mean temperature of the air with that of the interior of a horse-chestnut, 0.5 meter (19.68 inches) in diameter, it was found that the mean of the temperatures observed within the tree during thirteen months exceeded by 0°.36 (C.) that of the air at its surface, and by 0°.83 of the air on the north side and in the shade, a difference due probably to the fact that the thermometer was placed in a situation sheltered from the sun, while the tree was protected from the north winds by buildings adjacent, and was at the same time exposed to the solar rays. Some experiments made upon other trees established well the principle of the changing equilibrium of temperature, after more or less time, between the air and the trees, and the more rapidly as the variations of the air are less frequent. The difference in autumn and in winter is at its minimum, and in spring and in summer at its maximum.

The maximum temperature of the atmosphere takes place, according to season, between two and three o'clock in the afternoon, while in the tree it does not become manifest until after sundown. If we notice the effect of seasons, we find that it is especially in summer that the maximum is more marked, and then it is reached about nine o'clock in the evening.

The heat disengaged within the organs and tissues of vegetables does not affect, or but very slighly, the temperatures in which they are placed, and we must seek the principal cause of these changes in solar radiation and the temperature of the air. The diurnal variations of temperature in the air are easily determined, since this is the difference between the maximum and minimum of the day. But it is very difficult to find this variation in a tree, and we may arrive at this in a manner more or less approximately.

Observations upon temperature were made at Geneva from 1796 to 1800, at sunrise and sunset, and at two o'clock in the afternoon, in the air open to the north, and in a horse-chestnut of 0.6 meter (23.62 inches) in diameter. The maxima and the minima may be had by combining the temperatures at two o'clock and those of sunrise and sunset, the maximum taking place, as we have already shown, near or a little after sunset, and the minimum at about sunrise. The difference will give essentially the variations within the tree. By discussing the variations thus obtained in the air and in the tree, it is seen that in the years 1796, 1797, and 1798, the variations were, on the average, five times greater in the air than in the tree.

From observations made at the Jardin des Plantes from December, 1858, to July, 1859, it was found that the mean variations of tempera-

ture in the air and in the tree are in the ratio of 3.80 to 0.81; that is to say, they are 4.7 times greater in the air than in the tree, instead of being 5.89 times, as found at Geneva. This difference is evidently due to the poor conductability of the wood, which does not allow the changes of temperature in the air to be conveyed rapidly into the tree. We find in fact that very decided changes, but of short duration, are noticed in the air which cannot be appreciated in the tree.

The leaves and young green branches of the trees and the low plants that cover the meadows are in similar conditions as to warming or cooling, and produce like effects in radiation. It is therefore only in branches of a certain size, and in the trunks, that we can study the influence that the temperature of vegetables properly exerts upon the temperature of the ambient air. We may practically consider a green stem as a body covered with an envelope that possesses great emissive and absorbent power, by virtue of which its temperature is lowered or raised continually from the effect of celestial radiation on solar heat; but when the parenchymatous tissue is replaced by a cortical one, the wood within being damp and a poor conductor of heat, either in a transverse or a longitudinal direction, the movement of the heat then operates but slowly, and we no longer observe in the interior those rapid changes of temperature noticed in the young branches. We see, therefore, that the variations are much less in the trunk of a tree of certain volume than in the air. If the temperature of the air varies within extended limits but of short duration, the thermal condition of the tree is but little affected. If the changes, however, are moderate in extent, and of long period, the tree finally acquires the temperature of the air.

Every vegetable needs a certain degree of heat to enable its organs to act. If the temperature rises gradually, the parts dilate, and evaporation and the circulation of the sap are accelerated; if the temperature is lowered the opposite effects are produced. On the other hand, alternations of heat and cold give a new activity to vegetation. But the great variations of temperature within the tropics, between day and night, in the portions of the air that envelop the trees, become likewise manifested within the interior of the trees, and afford conditions that eminently favor forest vegetation.

The atmosphere is, therefore, the source from whence all vegetables derive the heat which their being requires for developing and accomplishing all the phases of their existence. The mean temperature of a place, and the daily variations and extremes of temperature in the air, are, therefore, the caloric elements that we are principally to take into account in the phenomena of vegetable life, and in researches relating to this vegetable life, and to the thermal influences of forests, and effects of woodlands generally upon the climate. Whatever heat may be generated in the tissues where the transformation of the sap takes place does not materially affect their temperature—at least it is not appreciable by our instruments, and whatever it may be it is dissipated. We have undertaken several series of observations upon temperature in different localities, within the woods and without, and to a certain distance from them, in order to determine the influence that the forests exercise upon the mean temperature. The results obtained will be made the subject of another memoir.

We now come to remark that vegetables possess within themselves the power of resisting, for a certain time, an extreme reduction of temperature without suffering organic lesions, as we have proved in a series of experiments, that leave no room for doubt upon this point. We have, from this, been led to think that there exists in vegetable organisms an

independent cause of conductability, which operates against this cooling to a degree below the freezing-point, and preserves them, for a certain time, against the disastrous effects of severe cold. This action varies according to the diameter of the tree, and probably according to the species to which it belongs.

In northern regions, the temperature of plants, as compared with that of the air, is more remarkable. M. Bourgeaud, in 58° of latitude, in places where the temperature goes down to the congealing-point of mercury, or to —40° (C.), observed the following facts:

1. The *Populus balsamifera* and *Abies alba* were observed, during the eight months from November, 1857 to June, 1858, at nine o'clock in the morning—the time of day when he supposed the temperature to be at about the average of the day—the mean temperatures of the air and of the poplar were the same; agreeing in this, with the observations of which we have above spoken, and going to establish the principle, by virtue of which the temperature of the plants tends constantly to become that of the ambient air, notwithstanding the causes tending constantly to increase or diminish this effect.

2. The monthly temperatures presented little difference in the trees and in the air, although they differed very greatly in their maxima and minima. In the month of January, for example, the maximum and minimum of the air were +6° and —34°.6 (C.), while in the poplar they were —2°.2 and —29°.7.

3. During the eight months of observation the mean temperature of the soil, at 0.913 and at 0.609 meters depth, was twice greater than in the air.

The thaw commonly comes in May; spring begins at once, and very soon afterward the summer is come. The vegetation is so rapid, that cereals sown in this month are harvested toward the end of July; the blossoms on the poplars appear when the temperature of the air is at +13°.47 (C.), while the frost is still in the ground to a depth of $0^{m}.609$ to $0^{m}.913$ (23.62 to 35.85 inches). The leaves appear on the first days in June, when the roots are still in a soil at the freezing-temperature, the effects being the same as are produced when we bury in a warm bed of soil the tops of vines while their roots are still in the open air. The buds and even the leaves begin to develop while it freezes from — 8° to — 10° (C.). We have here a new evidence of the influence of the temperature of the air upon the trees, even while the roots are in the frozen soil, in promoting and developing vegetation.

The *Populus balsamifera* and the *Abies alba*, as well as other species, are exposed to a cold of — 40° (C). without suffering in their organization; yet the roots of these trees find themselves in strata of earth that are not sensibly touched by the frost, thus affording a new proof that there exists a certain resistance to the cold at the extreme minima of the air, — 34°.6 (C.), while in the poplar it is but — 29°.7, and that the temperature in a tree may be twice as great as in the open air.

Having shown the relations that exist between the temperature of the air and its variations and those of plants, there remains to be shown what is the temperature of the air above that of trees of the first magnitude, such as the horse-chestnut, 21.25 meters high, at the top of which is placed one of the poles of an electric thermometer in contact with the leaves. It is shown, from multiplied observations, that the temperature of the air over the horse-chestnut depends chiefly on the thermal condition of the leaves and branches, which more or less warm or cool the ambient air, according as they are more or less exposed at the time to the solar rays or to nocturnal radiation.

It should therefore be found, as already remarked, that a tree, with its trunk, branches, and leaves, becomes warm or cool, like any other bodies immersed in the air, according as the sun is above or below the horizon. In the first they are warmed by the solar rays, and in the second they are cooled by the radiations of the night, until the tree is brought to an equilibrium of temperature with the air around it. The cooling of the night then begins, and if the sky is clear of clouds, it goes on in degree proportioned to the amount of cooling of the upper branches and the leaves, which gradually lose their heat by radiations into space. We may see from this, how the strata of air that envelop the tree maintain, during a great part of the night, a temperature higher than that of the air which is some distance off.

A tree which has been warmed by the effect of the sun's rays acts in turn by warming the air around it, and when it comes to rain suddenly, the temperature of the air becomes reduced, notwithstanding, at some distance around.

We will cite an instance: On the 9th of May, at one o'clock, after a strong electrical insolation, we had the following conditions:

Temperature above a horse-chestnut	19°.4 (C.)
Temperature to a little distance	18 .3
Difference	1 .1

Half an hour after a rain fell, and the temperatures changed as follows:

Temperature above the horse-chestnut	17°.5 (C.)
Temperature around	15 .2
Difference	2 .3

Here, within an interval of half an hour, the atmosphere that surrounded the tree had therefore cooled but 1°.9, while at a little distance away it had cooled 3°.1, so that the tree must have radiated heat in order to have warmed the surrounding air. The sun having reappeared some moments after, the temperature arose at both points of observation, but a little less over the horse-chestnut than at some distance from it, and at three o'clock these temperatures were as follows:

Above the tree	20°.8 (C.)
At a little distance	19 .2
Difference	1 .6

To get an idea of the warming of the air from the presence of the leaves, we will take as an example the temperature of the atmosphere in July, 1863, at nine o'clock in the morning, at three o'clock p. m., and at nine in the evening. They gave as monthly means as follows:

At 9 o'clock in the morning	21°.56 (C.)
At 3 o'clock in the afternoon	26 .76
At 9 o'clock in the evening	19 .20

We observe that the temperature of the air was at its maximum at three o'clock, and that it diminished about a quarter of this number of degrees by nine o'clock in the evening. The diminution of the internal heat of the trunks and branches continued to restore by radiation the losses sustained by the leaves in radiating their heat during the night, until 6 o'clock in the morning, when the temperature is the same at 1.33 meters from the ground on the north and at 16 meters above the ground on the south and at 21.25 meters at the tree-tops. At this time the celestial radiation ceased to predominate, and there was an equilibrium

between the effects of radiation between the earth and sky. In July, 1864, we found:

At 9 o'clock in the morning	21°.04 (C.)
At 3 o'clock in the afternoon	25 .94
At 9 o'clock in the evening	19 .00

The cooling continued until 6 o'clock in the morning, when the temperature was the same at 1.33 meters above the ground on the north, at 16 metres on the south, where it was 15°.5 (C.).

Taking the month of January in 1863 and in 1864, we had:

	1863.	1864.
At 9 o'clock in the morning	4°.57 (C.)	—0°.05 (C.)
At 3 o'clock in the afternoon	7 .41	+3 .30
At 9 o'clock in the evening	5 .13	0 .00
At 6 o'clock in the morning	3 .19	—1 .08

We see, therefore, that whether we take trees covered with foliage, or deprived of their leaves, the heat acquired during the day diminishes till six o'clock in the morning.

It is now well proved that the radiations of heat acquired from the sun's rays warm, and that celestial radiations cool, the adjacent air, a faculty which we did not suppose that they possessed, because we supposed that the evaporation from the leaves was always a cooling process. It may intervene to modify the effect, but it is not a dominating cause. This question will be taken up for further consideration in a future paper.

The experiments above mentioned were made upon isolated trees, but the results were the same in groups of trees which sheltered one another, so as to present an obstacle to the direct action of the sun, with the exception that the temperature of the trunk did not increase so much, other things being equal, as when the tree stood alone.

Forests, groves, and groups of trees ought practically to show the same results as the horse-chestnut, excepting that the effects of the heat, of which we have spoken, should vary according to the height of the trees, the spread of their branches, and the amount of leaves with which they were covered. What conclusions can we draw from these facts, as to the influence of forests upon the local climate? We will refer to this subject in a future memoir, but will here remark, that we should take into account the nature of the soil, as whether dry or moist—the greater or less facility with which the air circulates, the exposure, and other circumstances not now well understood, and which may vary according to locality. But as the woods by radiating the heat acquired from the sun may warm the ambient air, and as this air may be cooled by nocturnal radiations, ought we not to believe that the air they warmed should cause during the night a double current—the former of the warmed air upward, and the other of the cooled air toward the ground? The warm air, being carried by lateral currents, should ameliorate the temperature of the surrounding parts.

Within the tropics, and especially under the equator, where the sun's rays act with greatest power, and are least inclined, the trees ought to produce in high degree, the effects of which we come to speak, and which should be felt in the strata of air of neighboring parts. On the other hand, the radiations of the night, which are very great under a sky almost always clear, should act powerfully in hastening the cooling of the leaves.

The following fact illustrates, to a certain degree, the heat that may be emitted by the woods when warmed by solar radiation. Every one knows that during the intense heat of summer, in the middle of the day,

we may feel an oppressive heat in the woods. We may attribute it simply to the absence of currents of air, and this may be true to a certain point, but this appears to be the cause of this warming: when the branches and leaves, becoming warm, become so many radiators of heat.

We will now explain the mode of influence by which trees affect the temperature of the air around their trunks and branches, and may be able from this to draw the conclusion that the mean temperature of a place may be ameliorated by this cause. To aid in the solution of this question, it will be necessary to consult observations upon temperature made in places wooded and cleared, under the same latitudes, with the same geological conditions, and at the same height above sea-level.

[The author here cites from Jefferson's Notes on Virginia to show the immediate effect of clearing upon temperatures, as elsewhere more fully mentioned.]

We will pass to observations that inspire more confidence, such as those discussed by M. Boussingault, and made by him and Humboldt, and by Roulin, Rivero, and others, in localities between 11° N. and 5° S. latitude, where the celestial radiations act with full effect.

The mean temperature, on account of its small variations in the course of the year, is shown directly by that of the earth in the shade at 3 decimeters (11.8 inches) below the surface.

Observations show that the temperature of the torrid zone varies from 26°.5 to 28°.4 (centigrade), and that the abundance of forests and the humidity have a tendency to cool the climate, while dryness and aridity would have the opposite effect. These effects are observed at different heights on the Cordilleras, where the temperatures of middle latitudes occur.

Shall we inquire whether it is the same in localities wooded and not wooded, without the tropics, where, the mean temperatures being the same, the means of summer and of winter are different? No observations have yet been made upon this point. Former and subsequent observations tend to show, on the contrary, that clearing over a great area does not sensibly change the mean temperature.

Humboldt collected a large number of thermometric observations made at different points in North America, for the purpose of learning whether the mean temperatures had changed in a course of years. He remarks that he had records for sixty-three years (1771 to 1834), and returns from thirty-five military posts at which the thermometer has been observed, from the southern point of Florida at 24° 35′ of latitude, to Council Bluffs on the Missouri, and from a study of these records he arrived at the following conclusions:

These observations tend to show, contrary to the opinion very generally received, that since the first settlement of Europeans in Pennsylvania and Virginia, the climate has not become more uniform, more mild in winter or cooler in summer, either this side of or beyond the Alleghenies, in consequence of the great number of forests. We cannot, however, concur in this; and Humboldt himself admits that clearing tends to ameilorate the temperature, by removing three tendencies to cooling, viz: first, shelter to the soil from the sun's rays, and maintenance of greater humidity; second, evaporation from the leaves; and, third, the multiplication of surfaces, which have a cooling effect by reason of nocturnal radiations.

M. Boussingault, as we have already seen, came to opposite conclusions, since he found that where the forests are abundant the humidity

that results has a cooling effect upon the climate; while dryness or aridity produce the contrary effect.

It will be found, however, that if the mean temperature remains the same, the distribution of heat through the year would change, and that thus the climate would be modified. On the other hand, we cannot appeal to documents relating to cultivation, which will not bear serious examination, as we have shown in our treaties on climates. It is possible, however, to make an advance in the study of this question, by taking into account some facts not yet mentioned.

Observations upon temperature made in the interior of trees taken in isolated places, and at the periphery of their branches, show, as we have said, that trees act like other bodies when exposed or not exposed to the solar rays; that is to say, they become warm or cool, according to their absorbing, reflecting, or conducting power, which further shows that their thermal condition depends in a great degree upon the solar action. What may we infer relative to the influence of trees upon the temperature of the air and the changes that come from clearing? These changes come not only from the causes that we have mentioned, but also, as we need not repeat, from the nature of the soil; as whether dry or damp, calcareous, sandy, or argillaceous. Let us analyze the effects that these may produce.

Let us first consider a wooded soil. The trees become warm or cool, as already described; but what effect does this have if the soil is dry or moist? If dry, there will be no effect. If moist, the evaporation of the water will produce a constant humidity, which will depend in degree upon the temperature which the trees acquire, independently of that resulting from the transpiration from the leaves. The humidity, all things else being equal, which may be caused by the trees, should be greater in a wooded country, and on an argillaceous soil, which will retain the water because the roots do not pierce it, or penetrate with difficulty into the subsoil, which, if sandy, would favor the infiltration of water. In this case, the humidity would be only such as comes from the evaporation of the leaves.

What would happen when we clear a country with an impervious or a pervious soil? The effects would depend on the composition of the soil, and its power of absorption, radiation, and conduction, and of these we will endeavor to present the ideas of Schubler.

We will begin by the warming of soils exposed to the sun, and shall find the following conditions in different soils:

Maximum temperature of the upper strata, the mean temperature of the air being 100.

Designation of soils.	Humid soil.	Dry soil.
	°	°
Grayish-yellow silicious sand	37.25	44.75
Grayish-white calcareous sand	37.38	44.50
Pure gypsum	36.55	43.62
Yellowish poor clay	36.75	44.12
Rich clay	37.25	44.50
White calcareous soil	36.63	43.60
Grayish-black humus	39.75	47.37
Grayish-black garden-soil	37.50	45.25

We see that color and humidity are causes that exercise the greatest influence. The difference of temperatue due to these causes, with that of the ambient air, in the same soil, may amount to 14 or 15 degrees.

If we pass to the property of retaining heat, we shall find that, all else being equal, the silicious and calcareous sands, as compared with equal

volumes of different argillaceous or calcareous soils, in fine powder, or with humus, or with arable or garden soils, are the poorest conductors of heat. For this reason, sandy soils in summer, even during the night, preserve a high temperature, and we may conclude from this that when a sandy soil has been cleared, the local temperature should be raised, and the more so as cooling causes do not exist. After sands come, successively, argillaceous soils, arable and garden soils, and finally humus, which comes last. Representing calcareous sand, in its faculty for retaining heat by 100, we have the following relative classification: sand, 95.6; argillaceous soil, 68.4; garden-soil, 64.8; humus, 49.0.

We must further remember, that the faculty of retaining heat, is proportioned to the size of the particles. It is from this reason, that a soil covered with silicious pebbles, cools more slowly than silicious sands, and that gravelly soils agree better with the ripening of grapes than chalky and clayey soils, which cool more rapidly. We see, therefore, by this, how important it is, in the examination of the thermal effects resulting from cooling, to have regard to the physical properties of the soil, when once it has become denuded. This is probably the reason why Humboldt drew the conclusions deduced from thermometric observations made at stations in North America, in not taking into account the nature of the soil of the denuded countries, and M. Boussingault came to different results by taking these causes into consideration.

It is therefore well proved that a soil of silicious sand and gravel, when cleared, ought to raise the mean temperature of the air more than all other soils, while at the same time it removes one cause of humidity, while if the soil is argillaceous, dry or humid, the property of warming the air and of retaining heat, as compared with the former, is in the ratio of 68.4 to 100. The thermal effect ought, therefore, to be much less in clearing a dry ground.

We see from this in what manner we should look upon the influence of clearing upon the temperature of the air. The effects are, moreover, so complex, that we can only determine the result by the aid of daily observations of temperature. It will also be necessary to collect maxima and minima temperatures, as these play an important part in the constitutions of climates as regards the nature of the soil. We will take up this subject again in a future memoir.

The following example is furthermore calculated to give an idea of the influences which vast forests may exert upon the climate of a country. The presence of immense forests in the tropical regions of the African continent, under the meridians of Western Europe, doubtless modifies the ascending current of hot air resulting from the warming of a sandy soil, and which descends within the middle portions of Europe. If in the course of ages, the sands of Sahara should become covered with wood, these sands would not become warm in the solar heat as now, and, as a consequence, the south winds which now ameliorate our climate, having no longer so high a temperature as now, would render the climate more rude. It is sufficient to prove this, if we examine what passes on the American continent, where the tropical regions are covered by vast forests, immense savannas, or great water-courses. The descending currents of air do not warm and temper the climate of countries situated in the middle latitudes of North America so much as those of warm air coming from the Sahara, and hence the difference between countries located in the same latitudes. It is precisely for this reason that the American continent in the same latitudes is colder than ours, judging from the cultivation of the two continents, and the direction of the isothermal lines, in regions similarly exposed.

It will not suffice to study the calorific effects of clearing upon climates. We must seek to ascertain the action they exert upon springs, and the physical effects they produce in mountainous regions upon a denuded soil, as well as the effects that follow clearing upon soils of wet clay.

We will here make an observation that is not without some importance. We have seen above that a tree becomes warm or cool like any inorganic body, and that in proportion as the leaves become cool by night from nocturnal radiation, this loss is repaired by heat radiated from the trunk and branches. This condition of things, which has not heretofore been pointed out by physicists, hinders the air from cooling, as much as if this radiation from the trees had not taken place. The effect of woods in cooling the air is not as great as has been supposed, and the condition of the soil, moreover, modifies this influence in a singular degree.

On the effects of clearing upon springs and water-courses.

The effects of clearing upon springs, and the amount of living waters that flow through a country are most important points for consideration, and require serious attention. The difficulties in recognizing these effects are the greater when we are unable to say *a priori* whether a forest or a part of a forest supplies any particular spring or river.

Springs are in general due to infiltrations of rain-water into a pervious soil, which it traverses until meeting an impervious stratum, over which it flows when inclined, until it comes to the surface, forming rivulets, streams, or other running waters. The water in wells has no other origin. Great springs are commonly found in the mountains. Forests contribute to their formation, both from the humidity of the soil that they produce, and the obstacles which they oppose to evaporation from the surface. Besides this, the roots of the trees, in separating the soil, render it more pervious, and thus facilitate infiltration. We cite in the memoir, a certain number of characteristic examples, but will here refer to but three of the most remarkable:

Strabo informs us, that it was necessary to take great precautions to prevent Babylon from being washed away by the waters. The Euphrates, he says, began to swell at the beginning of spring as soon as the snows began to melt in the mountains of Armenia, and filled the banks at the beginning of summer, necessarily forming vast masses of water, which would inundate the cultivated fields if not diverted by means of ditches and canals, and that when these canals were full, the waters spread over the plains like the Nile. This state of things no longer exists, and M. Oppert, who traveled through Babylonia some years since, relates that the mass of waters transported by the Euphrates is much less than it was ages ago; the filling of the banks no longer occurs, the canals are dry, the marshes become dry during the powerful heats of summer, and that the country has ceased to be insalubrious. This disappearance of the waters he assures us ought to be ascribed to the clearing off of forests on the mountains of Armenia.

These effects are incontestable, although there have been some persons who denied them. The examples that I am about to present furnish proofs much more forcible, because they are derived from observations that inspire confidence.

De Saussure[1] notices the diminution of waters in the Swiss lakes as a result of clearing, especially in Lakes Morat, Neufchâtel, and Bienne.

[1] *Voyage dans les Alpes*, ii, chap. xvi.

Choiseul Gouffier was unable to find now in the Troad the Scamander River, which was still navigable in the days of Pliny. Its bed is now entirely dry; and the cedars that once covered Mount Ida, where it takes its source, as did also the Simois, no longer exist.

M. Boussingault,[1] who has studied this question during his sojourn in Bolivia, took for the subject of his observations the lakes situated in the plains or upon different stages of the mountains. The valley of Aragua, in the province of Venezuela, is a short distance from the coast, in a very favorable climate, and is very fertile. It is land-locked, the streams that flow into it having no outlet into the sea, but unite in forming Lake Tacarigua or Valenciana, which, when Humboldt saw it, at the beginning of this century, had been showing for thirty years a gradual drying up, of which they knew not the cause.

Ovideo, the historian of Venezuela, in the sixteenth century, reports that the city of New Valencia was founded in 1555, at half a league from Lake Tacarigua. This city, when seen by Humboldt in 1800, was 2,700 toises distant, showing, by many proofs, the retreat of the waters. According to this celebrated traveler, the diminution of the waters should be attributed to numerous clearings that had been made in the valley.

In 1822 Boussingault learned from the inhabitants that the waters of the lake had very considerably raised, and that lands once cultivated were now under water.

We should add, that during the period of twenty-two years, the valley had been the theater of a bloody conflict in the war of independence. Its population was decimated, the lands remained uncultivated, and the forests, which grow with astonishing rapidity within the tropics, had reoccupied a large part of the country. We see from this the influence that forests may exert upon the waters of a country, as the lake had lost its waters by clearing, and had regained them as the country was restored in forests.

M. Boussingault cites several other examples leading to the same conclusion relative to the influence exerted by great masses of forests upon the living waters of a country. We will cite two of these that are remarkable.

In 1826 the metalliferous mountains of Marinato presented but a few miserable cabins, inhabited by negro slaves. In 1830 this state of things no longer existed. There were numerous establishments and a population of 3,000 inhabitants. They had been obliged to cut much of the wood. The clearings had only begun two years before, yet the effects were already seen in the failing of the waters used in driving the mills. Yet a rain-gauge showed to M. Boussingault that the amount of waters falling the second year had been greater than that of the first.

The second example is taken upon the plateau of New Grenada, at an elevation of 2,000 to 3,000 meters, where the temperature of the year is from 14° to 16° C. The inhabitants of the village of Dubaté, situated near the two lakes that were united some sixty years before, had noticed a gradual wasting of the waters, so that lands which were under water thirty years before were now cultivated, and an inquiry as to the cause led tc the conclusion that the decrease had been caused by the numerous clearings of the forests that had taken place. Some lakes, such as that of Tota, a short distance from Tuguené, in localities not cleared, had suffered no diminution in their waters.

Mr. Desbassyres de Richemont has likewise shown, that there exists on Ascension Island a fine spring of water, which was lost by clearing and restored when the mountain was reforested.

---

[1] *Annales de Chimie et de Physique*, xiv, p. 113.

To complete the documents proper for elucidating the question, we will add still other important observations. M. Berghaus[1] found that the volumes of water in the Oder and the Eble had diminished between 1778 and 1835 in the former, and between 1828 and 1838 in the latter, and that this decrease still continued, and, remaining so, it was at length necessary to change the form of the boats; and statistics show that it can only be ascribed to the clearing of mountains.

Attempts have been made to ascertain whether the amount of water falling in different countries in Europe have diminished, but without finding proofs. In fact, since 1689, it has been observed that the amount of water falling at Paris slightly increased, rather than diminished Cesaris has noticed the same at Milan, since 1763, and it is the same at Rochelle and in the valley of the Rhône.

The hypothesis of the diminution of rains must not be rejected until we consider whether the number of rain-falls has changed, and take into account the fact generally admitted that great rains furnish more water to the rivers than the same amount of water falling through several days, with intervals of dryness between. But the discussion of observations still does not clear up the question, and we must still appeal to the changes wrought upon climate by cultivation.

It may possibly happen that earthquakes may disturb a spring by moving the strata, but this is rare. A great number of facts, on the contrary, tend to show that the diminution of volume is found almost immediately following upon great clearings. We may cite especially the example of the waters of Marmato, already noticed.

Other examples may be mentioned that are not without interest. The Romans were able to bring to Orleans the waters of the fountain of l'Etuvée, which is now entirely dry.[2] Important excavations, undertaken some years since, have brought to light the foundations of Roman structures for supplying water where spring no longer exists, and a stream which empties into the Loire east of Orleans, and contributed in the siege of 1428, and to the turning of mills, no longer exists as it did when Orleans had great forests on that side, now cleared. By reason of this clearing the wells in the city give less water than formerly, so that the municipal authorities have been obliged in recent years to bring waters for domestic use from the sources of the Loiret, at a cost of 300,000 francs.

In the canton of Chatillon-sur-Loing (Loiret) there is a commune named Sainte Geneviève-des-Bois, which was once wooded, but now there exists only some little clumps of trees here and there. A stream flowed by the village which is now a dry channel, except when filled in winter.

---

[1] *Cours d'Agriculture.* By M. Gasparin, ii, 146.

[2] An analogous instance is presented in Patroon's Creek, that some thirty years ago was taken and the mill privileges purchased for a large sum by the city of Albany, N. Y., for supplying that city with pure water. This stream had been perennial, and its ample supply mainly derived from the drainage of a flat, sandy country, with few springs, but an abundance of water in the soil so long as it remained covered with forest vegetation. This growth having largely disappeared, the stream has failed, and now its diminished supply is made up by pumping from the Hudson River.

An instance of conservative hydrology of different results is presented on the opposite side of the river and but a few miles distant. Two streams that flow into the Hudson, in the city of Troy (the Poestenkill and Wynantskill), have an ample amount of hydraulic power maintained through the summer by the construction of reservoirs in the hilly country around their sources, for retaining the excess of winter rains for discharge at the time when needed throughout the summer. Although the forests have no direct connection with the water-supply in the latter case, there can be no doubt but that their presence would contribute greatly to the cost of maintenance by easing the violence of floods and securing the more uniform delivery of the waters. (H.)

In discussing the important question of the influence of clearing upon water courses, we come to the following conclusions:

1. Great clearings diminish the quantity of living waters that flow in a country.

2. It cannot be said that this diminution is caused by a less annual rain-fall or to a greater evaporation of rain-water, or to these causes combined, or to a new distribution of the rain-water.

3. Cultivation established in an open arid country dissipates a part of the currents of water.

4. In countries where no change in cultivation has occurred, the amount of living waters appears to be constantly the same.

5. Forests tend to maintain the living waters and to regulate their flow.

6. The humidity that prevails in the woods, and the intervention of the roots in rendering the soil more permeable, must be taken into consideration.

7. The clearing of a mountainous country exercises an influence upon water courses and springs in the plains and especially upon the latter.

8. The action which the forests exert upon the climate is very complex.

With the means of drainage we now possess, there is no longer any fear of marshes as a consequence of clearing. We need not fear that the clearing of a country will always bring with it sterility, and will cite as examples England and Spain, of which the former has only 2 and the latter but 3.17 per cent. of wooded surface. The former has a marine climate, where the southwest winds, charged with vapor to the point of saturation, often prevail, causing fogs at the least reduction of the temperature; while Spain has a different climate, but the more fertile parts are watered by great rivers, and the great plateaux are veritable deserts.

From all this it results, that if we come to clear a great forest in the vicinity of a fertile plateau with some springs, ought we not to fear that the latter will partly or wholly disappear, and impoverish the country? The clearing of a sandy country may bring drifting sands upon the neighboring plains, as it is easy to conceive from the explanation which M. Chevreul has given to the formation of dunes in the Landes of Gascony. The wind drives the sand along until it meets with some obstacle, where it forms a mound, or the dunes obstruct the waters, which infiltrate into the sands and dampen their base. The waters by capillary attraction cause the grains of sand to adhere, and fix them in the soil. The winds take only the dry parts above, which go to form new dunes beyond the former; and so the process goes forward until it ends by finally ensanding the whole plain.

A forest placed so as to oppose the passage of a current of damp air charged with pestilential miasms, will sometimes protect all that is behind it, while the exposed part is liable to diseases, as we see in the Pontine marshes, where the trees have the effect of taming the infected air and purifying it of its miasms.

The forests have another effect upon climates. High trees serve as conductors of electricity, withdrawing this element from the clouds, and checking the disastrous effects of storms.

The reboisement of mountains is a first necessity for their preservation, and results in the following manner:

1. From the facility with which rain-waters penetrate the soil, and even the subsoil, which the roots open to infiltration.

2. From the effects produced when the forests oppose an obstacle to

masses of air saturated with vapor in motion, which does not fail to turn to rain when they are raised, crowded as they are by the obstacle.

3. From the humidity that commonly prevails in the interior, and near the woods, which leads to the precipitation of dew, when the temperature is lowered.

The transformation of cleared lands into marshes is real. We will cite examples not in Asia Minor, as has been done, but in France. When the trees are cut, the roots die, and the soil becomes compact. La Brenne, situated between the Indre and the Creuse, presents a circular area of over 200 kilometers in circumference, or about 80,000 hectares. The soil of that region is argillo-siliceous, resting upon an impervious bed of clay, of more or less thickness, which opposes the infiltration of the waters. It is covered with ponds, to which are attributed the intermittent fevers to which the population are a prey. This region was covered ten or twelve centuries ago with forests, interspersed with meadows watered with living waters, and there then existed neither ponds nor marshy grounds, and it was renowned for its fertility, its pasturages, and the sweetness of its climate. On the clearing of of these woodlands the ponds succeeded, and the lands speedily became unproductive and valueless. Their increase had come to such a point that, in 1714, Bourbet-en-Brenne counted but 309.

The same thing was seen in the Sologne, which represents an area of 450,000 hectares, and of which the insalubrity is proverbial; but this deplorable condition did not always exist. Historical documents show that a great part of this country was formerly wooded. Upon clearing, followed the disappearance of the waters, wastes, and insalubrity. Now a clearing might not bring a like condition of things, since we have means, by means of drainage, of rendering fertile marshy lands that have been in this condition for many years.

In the effects produced in mountains, we are to notice the influence of roots which favor the infiltration of rain-waters, and feed the springs. In such a country, clearing leads promptly to the formation of torrents, of which the Alps present numerous examples.

The effect, when the slopes covered with detritus of rocks are crowned with vegetation in vigorous growth is, that the roots strongly interlacing form a net-work, and we see it rapidly disappear when the firs and larches on the flanks of the mountains are removed. We see that when inconsiderate cuttings are made on these slopes that the waters flowing there, carry down the vegetable soil, and a ravine is soon formed. This ravine enlarges, and becomes in time the bed of a torrent, while nothing of this is seen where the forests remain untouched. The whole eastern part of the department of the Hautes-Alps presents numerous effects of this kind.

We see, therefore, that the presence of a forest upon the soil, strongly inclined, opposes the formation of torrents, while clearing delivers the soil to this destruction. It is easy to explain the effect that follows as soon as the soil is again covered with vegetation, first of low plants, then with trees, as we have said, forming a kind of net-work that gives it consistence while the branches and leaves break the force of the storms. The trunks, shoots, and brush oppose multiplied resistances to the currents that would otherwise erode the soil. The effect of vegetation is therefore to give greater solidity to the soil over its whole surface, and prevent it from being carried into the channel-ways, as would otherwise happen. The soil, when opened by the roots, and covered with a spongy humus, absorbs a part of the waters, that, being hindered from running off upon the surface, sink into the interior and become a

supply for springs. These are the benefits resulting from the presence of forests upon mountains and inclined slopes exposed to torrential rains.

[The researches of M. Becquerel tended to show, that when the air is otherwise calm, and the sun is shining warmly, there is a current of air flowing out from forests into the fields adjacent. At night, the tendency is inward, this alternate movement inward and outward being analogous to land and sea breezes in the insular climates of warm latitudes, and, in fact, due to the same cause.

M. Tissandier, in a note addressed to the French Academy of Sciences, October 10, 1873, records an observation made by him in a balloon, to the effect that in passing over a large body of forest, the hygrometer indicated a decided increase of moisture in the air, which disappeared as he passed from thence over the open fields. This would seem to indicate that from over great masses of forest there is an increase in the amount of vapor from evaporation, or a *relative* increase from a reduction of temperature, or both. He also noticed, as was known before, that the hygrometer indicates more dryness as we rise above the surface.]

EFFECT OF CARBONIC-ACID GAS AND OF AQUEOUS VAPOR UPON THE RADIATION OF TERRESTRIAL HEAT.

The presence of these gases in the atmosphere, near the surface, has been shown by the experiments of Prof. John Tyndall to afford great protection by preventing the radiation of terrestrial heat, while they afford almost no obstruction to the transmission of the direct heat. In this effect they resemble the action of snow, ice, and many other bodies which are *transcalescent*, as to heat of high intensity; but impervious to heat of low intensity as that given off by moderately warm bodies, such as the soil warmed by the sun.[1]

It is a common remark that the absence of dew on a summer night is a prognostication of rain. This seemingly contradictory statement, that there is less dew when there is most moisture in the air, may be reconciled with reason, if we admit that the radiation of heat by the earth is hindered by the stratum of moist air that lies upon its surface, and that as a consequence the surface does not cool down to the dew-point.

EFFECT OF VEGETATION UPON THE RAIN-FALL, AS OBSERVED IN AUSTRALIA AND TASMANIA.

An observer, in writing upon the climate of these countries, remarks that the influence of winds, great as it may be, is not the only one which increases or diminishes the fall of rain; that of vegetation is nearly equal to it. The refrigerating power of plants, acquired through the nocturnal radiation of heat, and their feeble absorption of heat during the day, is exemplified in a striking manner by a comparison of the quantities of rain condensed by the mountain districts—the one richly wooded, the other but scantily clothed with vegetation. On Middlesex Plains, a dependency of the Circular Head Company, 2,700 feet above the sea, the rain is less than on the Hampshire Hills, which average 1,800 feet above the sea. The rich arborescent vegetation found on the latter, and the partial barrenness of the former, thus differently influence the condensation of the floating vapors.

The influence of vegetation on the amount of rain is still better exem-

---

[1] This subject is further considered in Prof. T. Sterry Hunt's *Chemical and Geological Essays* (1875), p. 48.

plified by a comparison of the registers of the two stations of the Van Diemen's Land Company. At Circular Head, a neck of land which projects into the sea, clear of timber and under cultivation, it rains less than at Woolnorth, also on the sea-coast, and equally exposed to the north, but surrounded by a thick forest of luxurious growth.[1]

The climate of New South Wales and Van Diemen's Land is very different from what it was before these colonies were brought within the pale of civilization. The destruction of thick herbaceous underwood *scrubbs* and thick interwoven *forests* must have necessarily rendered the climate drier. The 250,000 acres of cultivated land, freed from the bad conductors of heat which covered them, have contributed toward the increase of the mean annual temperature. The climate, though thus drier and hotter, is far from being improved.[2]

EROSION OF SOIL WHEN NOT PROTECTED BY VEGETATION.

Allusion has already been made to the protection afforded by woodlands against erosion from rains, and the formation of torrents. Extreme examples of these effects can nowhere be more strikingly observed than in the interior of our continent, in the arid, and still for the most part uninhabited, regions, where slender pinnacles of rock mark the former thickness of strata, since removed, and cañons of immense depth afford passage to rivers that once flowed near the surface. The study of these wonderful results of erosion belongs to geology, and although, from the presence of fossil wood in abundance, we know that forests existed in these regions in the most recent of geological periods, and possibly within the time that man has existed, we are wholly left to conjecture as to their agency in retarding the ancient flow of waters, or the erosion that may have followed their removal. We simply know that these effects are comparatively recent, and that these processes are still going on. But European experience has unhappily afforded abundant examples within the observation of the living, and still more, within the period of historical record, more especially in the region of the Alps and Pyrenees.[3] They are liable to occur wherever loose soil upon steep slopes is exposed to rains, without the protection afforded by vegetation, and especially of woodlands. These damages, beginning with the wearing of enormous chasms in the mountains, transport these materials to the fertile valleys below, which they sterilize by covering the rich alluvial soil with stones and gravel. The river-beds are raised and become shifting channels, wholly unfit for navigation or other useful purposes, and dangerous on account of the uncertainty of their changes, when not confined between rocky banks; or if held between dikes, these must be raised more and more every year, until sometimes, as in the Po, the bottom of the river becomes raised above the level of the country adjacent, and fearful inundations are threatened at every river-flood.

In an official report recently addressed by M. Bouquet de la Grye to the Administrators of the Domains in Roumania, the following conditions of the valleys in that country from the effect of torrents are described, and may serve to give an idea of the general manner in which these agencies operate:

---

[1] *Physical Description of New South Wales and Van Diemen's Land*, by P. E. Strzecki, pp. 192, 193.

[2] *Ib.*, p. 239.

[3] Abundant instances of destruction from this cause are given in the work of Mr. George P. Marsh, entitled *Man and Nature;* and in his later work, *The Earth as modified by Human Action.*

I should not feel that I had performed my duty in the high trust with which you have honored me, until I had called your attention very particularly to the condition which the destruction of forests has produced in the richest of agricultural and pastoral valleys.

In following the course of the rivers I have found their beds everywhere incumbered with sand washed from the mountain sides by the torrents that flow down them. These streams bring down at every freshet those materials that are being eroded along their banks, and leave in the place of fertile intervales nothing but vast banks of gravel and sand. The rivers having no fixed channels can neither be used for navigation nor irrigation, nor for mills, for these deposits make it impossible to perform any durable work of excavation or embankment.

This condition of the streams is plainly due to the gullying of the hills on account of the destruction of the vegetable covering, whether of trees or sod, which, while it remained, afforded complete protection to the soil on the hills and mountains and sheltered them from erosion. We may see in fact that these ravines multiply as we approach the villages, and that they become less as we pass into the wooded regions. The flow of the waters is regulated in like manner, being almost uniform in the woods but appearing as torrents when they reach the naked valleys. Numerous examples might be given in which these erosions following the cutting off of woods have been arrested as soon as the surface was protected from the range of sheep and goats and became covered with herbage and bushes.

I have seen in no other country the destructive effects following the removal of the natural covering so intensely manifested as in Roumania, for the reason that in this country, the soil is mostly alluvial materials—sand, rounded pebbles, clay, and vegetable mold, with no cohesion to hold them. It therefore follows that in sloping places, where this soil is exposed, the finest thread of water traces a little furrow, which soon becomes a deep ravine. The materials loosened by the currents that form on the slopes from the melting of snows or from the rain-fall slide in great sheets to the bottom, overwheming fields and hamlets and obstructing the roads. They are then taken down by the rivers, filling up their channels, and often changing their course.

The peasants, who have become owners of a large part of the valley-slopes, clear what they can cultivate, and allow their flocks of sheep and goats to range over the rest till all traces of vegetation are gone. Their feet loosen the soil, and directly the destruction begins, the banks of the deepening channels continually falling in as they gain in depth. We may at once foresee that in the near future the valleys will become wholly uninhabitable unless a remedy is at once applied to this growing evil. The danger appears so serious, that it calls for the most prompt and energetic action. Roumania should have as much solicitude for its mountains as Holland for its dikes, for it is threatened by its torrents as much as that country is by the sea.

The remedy proposed, was a law of property, which should stop these clearings, that ruin both the soil and owners, as well as the owners below, and enforce a system of cultivation, that should arrest these damages by removing the cause. The owners in the lower valleys should have the means to compel their neighbors above to take the measures necessary to prevent their own ruin. In the case of Roumania, it was suggested that this legislation should not be put in charge of the forest administration, but rather in that branch of the service which watches over the public welfare, and to those that have charge of navigation, and the maintenance of roads and bridges.

EFFECT OF CLEARINGS UPON THE CLIMATE IN THE SIERRAS.

The rapidity with which the woodlands are being cleared off to supply fuel for smelting ores and other purposes of mines in the Pacific States, has already been repeatedly noticed in this report. The effect of this denudation upon the climate is thus discussed by a writer in the *Virginia Enterprise*, of Nevada:

It will be but a very short time before we shall be able to observe the effect that stripping the fine forests from the sides and summit of the Sierras will have on the climate of this State and California. In a very few years every accessible tree, even to such as are only of value as fire-wood, will be swept from the mountains. Even now this has been done in some places. It is to be hoped that a new growth of pines or

timber trees of some kind may spring up on the ground that has been cleared; but we do not hear that any such growth has yet started.

Already one great change has occurred that is evident to the most ordinary observer, which is the speedy melting away of the snow on the mountains. It now goes off at once, in a flood, with the first warm weather of spring, whereas formerly, being shaded and protected by the pines and other evergreen trees, it melted slowly, and all summer sent down to valleys on both the eastern and western slopes of the Sierras constant and copious streams of water. Instead of a good stage of water in our streams throughout summer, as in former times, there is a flood in the spring, and when this is passed by our rivers speedily run down, and, being no longer fed from the mountains, evaporation leaves their beds almost dry when the hot weather of summer comes on.

The mountains being stripped of their trees, there will be nothing to shade the rocks and earth, and both will absorb a sufficient amount of heat from the rays of the sun during the fall, and even until far into the winter, to melt any light snow that may occur. The result will be that our autumn weather will reach further into winter, until at last we shall have no winter worthy of the name. On the California side of the mountains the effect will be much the same. The hot weather of the valleys will extend over the foot-hills and gradually reach up into the mountains.

Statements like these might be multiplied indefinitely,—not drawn from isolated observations, but from the experience of all countries where mountains once covered with vegetation have been cleared by man or have been overrun by wide-spreading fires. We will now consider the measures that have been adopted in several countries of Europe for arresting further injuries from this cause and for restoring damages when done.

REBOISEMENT.

We use this term[1] to designate the process of replanting of hilly and mountainous regions that have been exposed to the action of eroding torrents, due to the stripping off of forests by improvident clearings, and even by pasturage, more especially by sheep and goats, so that the naked soil becomes exposed to the rains. These results have been more particularly observed in the Alps, the torrential rains being brought by a particular south wind called the *faehn*, which is generally violent, and pours down an abundance of rain. The waters begin to trickle down the slopes where vegetation has been removed, and at once to wear little channels, which, presently enlarging in width and depth, become at length enormous chasms.[2] The materials are swept down into the channels of the mountain streams, and the turbid mass of soil and rocks is borne down with overwhelming force, until it reaches the fertile alluvial plains below, where, spreading out, it covers fields and gardens with vast deposits of sand and gravel, sterilizing the country the whole dis-

---

[1] We adopt this word from the French because we have nothing in the English language that concisely expresses the idea. It is already in common use by English writers, and this fact appears to render further apology needless on this occasion.

[2] The desolation of mountain regions by the clearing of forests and by pasturage of flocks is also strikingly illustrated in the Pyrenees. This region in the last century was almost entirely out of account in the agricultural and commercial reports of France. The slopes were timbered with forests of great extent, which, from want of markets and ways for transportation, remained unproductive, and to some extent unknown. On the top, where forest vegetation ceased, sufficient herbage was found for the pasturage of flocks in summer. The plains were poorly cultivated, and inundations were much less frequent and less destructive than nowadays. As roads came to be opened, the profit from sheep and cattle became greater, and the clearing of forests was begun, to make room for pasturage, and to some extent for timber, until by degrees the slopes of the mountains were denuded, and the rains, having nothing to hinder, began to form eroding torrents, the south slopes suffering most, because first cleared and directly exposed to the sun's heat. The extremes of flood and drought became excessive, and extensive tracts have been ruined for present occupation from this source.

tance from the beginning of their course to their end, and driving the inhabitants from a region they can no longer inhabit.[1]

These injuries have been going on for many years, but more of late, as the causes have increased. The subject had from time to time attracted the attention of observers,[2] but it was not till 1860 that the French Government took action in the matter, a measure to which it was led by the reports made upon the causes and effects of inundations that had devasted certain regions of the country a few years before, and especially in May, 1856. In this month violent and protracted rains fell throughout France, and most river-basins were inundated to unprecedented extent. In the valley of the Loire and its tributaries, about a million of acres, including many towns and villages, were flooded, and the loss was almost beyond calculation. In the valley of the Rhone the injury from an invading army could scarcely have been more disastrous. Public attention was everywhere awakened, and these discussions, and the inquiries which they stimulated, finally led to the passage of the *Code du Reboisement des Montagnes* on the 28th of July, 1860.[3]

Before stating the ideas embraced in this Code, it may be well to mention some of the theories proposed by writers of various degree, from engineers of great experience and high culture, down to those who, without knowledge, presume to offer their views that scarcely rest upon the shifting sands of public opinion.[4] Longitudinal dikes, transverse

---

[1] In the French department of the Haute-Alps the mountain valleys had diminished 11,000 in population in twenty years. The measures of reboisement attempted by the government met with violent opposition from the peasantry, and they were allowed to substitute *gazonnement*, or sowing of grass. The result has been excellent, as the covered soil will absorb and hold the rains in some soils with good effect. This region is now slowly recovering from its injuries, the streams are becoming clear and more gentle, and the bridges are not liable to be swept away as formerly.—(*Nature*, December 9, 1872.)

[2] Among the more important of these was the work by M. Surell, published in 1841, entitled *Étude sur les Torrents des Hautes-Alpes*. The author had been engaged in engineering operations, and began these studies for publication in the *Annales des Ponts et Chaussées*, but was encouraged to prosecute his researches, and finally contributed this most valuable memoir to our knowledge of the subject. In 1870 a new edition appeared—with a supplementary volume in 1872 by M. Cezanne.

Many other authorities are cited in the recent work by John Croumbie Brown, LL.D., entitled *Reboisement in France, or records of replanting of the Alps, the Cevennes, and the Pyrenees with trees, herbage, and brush, with a view of arresting and preventing the destructive consequences and effects of torrents.* (London, 1876, pp. 351.) This work is a most valuable source of information upon the subject, and the references that he gives, lead to a very full study of all questions involved.

[3] The address to the Emperor, by M. Magne, Minister of Finances, dated Paris, February 2, 1860, sets forth in detail the motives prompting legislation upon this subject, and names the sum of ten millions of francs as necessary for subventions and works of replanting.

It appears from a pamphlet published by A. Marchand, in 1849 (*Mémoire sur le Reboisement des Montagnes, adressé à la Direction de l'Intérieur du Canton de Berne*), that the attention of the French Government had been called to this subject, and measures tending to arrest the damages then painfully apparent had been taken. Drying-houses for seeds had been established, and extensive purchases of seed had been made, amounting in one case to 27,948 pounds of the seed of the *Pinus sylvestris*. During the last four years 4,451 hectares had been replanted in the Conservation of Strasbourg, and 8,331 hectares in the Vosges.

The arguments used by this writer are singularly clear and forcible, and his illustrations of the necessity of reboisement, especially in Switzerland, are impressive and convincing. Yet he appears to have failed to secure attention to the importance of the subject at that time, and not until a quarter of a century afterward, was legislation secured tending to effectual remedy of the evils which were then as apparent as at the present day.

[4] "Assuredly," says Montaigne, "it is wonderfully strange how unstable, diverse, and wavering are human opinions, and how unwilling we are to agree upon a constant and uniform idea." This expression of the philosopher of Bordeaux applies to all humanity, and was not less forcibly shown in the discussions that led to the Code of Reboisement

dikes, and dams of various descriptions, absorbing-reservoirs, lateral canals, artificial basins, horizontal ditches, and other remedies, all had their advocates; but while some of these were necessarily made a part of the preliminary labors and are still important in their way, a philosophical train of argument finally led to the true theory of arresting the rains before they had begun to do damage.

French code of Reboisement of mountains, *July* 28, 1860.

ARTICLE 1. Subventions may be allowed to communes and public bodies, or to individuals for replanting lands on the tops or slopes of mountains.

2. These aids may consist either in the delivery of seeds, or plants, or in premiums in money. In those given by reason of the work done for the general good, and in cases of communes and public bodies, regard is to be had to their resources, and the sacrifices they must make, and to their need, as also to the sums given by general councils for reboisement.

3. Premiums in money given to individuals cannot be paid until after the work is done.

4. In cases where the public interests demand that works of reboisement should be made obligatory, either on account of the condition of the soil, and the dangers that may happen to the lands below, proceedings are to be had as follows:

5. An imperial decree, issued in council of state, declares the public utility of the works, fixes the boundaries of land in which it is necessary to execute the reforesting, and the time within which it must be done. This decree is preceded (1) by an open inquiry in each of the communes interested; (2) by a deliberation in the municipal councils of these communes, in conjunction with those most important; (3) the advice of a special commission, composed of the prefect of the department or his delegate, a member of the general council, a member of the council of arrondissement, an engineer of bridges and roads or of mines, a forest-agent, and two landholders of the commune interested; (4) the advice of the council of the arrondissement, and that of the general council.

The *procès-verbal* specifying the lands, the plan of the places, and the project of the works, prepared by the forest administration, with the concurrence of an engineer of bridges and roads or of mines, are to be deposited in the office of the mayor during the inquiry, the duration of which is one month, beginning with the publication of the prefectoral order, which prescribes the opening of the inquest, and the meeting of the municipal council.

6. The imperial decree is to be published and posted up in the communes interested. The prefect is also to notify the communes and public bodies, as well as individuals, by an extract of the imperial decree, concerning the indications relating to the lands belonging to them. The act of notification shall show the limit of time allowed for the work of reboisement, and if there is occasion, the offer of aid from the administration on the advances it is disposed to make.

7. If the lands included within the limits fixed by the imperial decree belong to individuals, the latter are to declare whether they will undertake to do the replanting themselves; and, if so, they are to be held to execute the work within the time fixed by the decree. In case they refuse or fail to perform agreement, proceedings may be

---

in France, than in those now had in this and other countries upon questions of public economy that are arising, especially with regard to the effects from clearing. But in these it is to be hoped they will lead to one conclusion: *that every owner of land should grow his own wood.* This cannot be begun too soon, and cannot well be done too far, for a market will always be found for surplus products near home. It may in fact be said to embody the American Code of Forestry, implying, of course, an intelligent understanding of best methods and an ambition to gain the best results.

The reasoning of those who opposed the measures for reboisement in France was at least often amusing. While some writers were promising that their measures would prevent all inundations, invite rains, protect against dangerous winds, suppress malaria, insure salubrity, and guarantee against foreign invasions by affording means for obstruction, others inquired, "Were there ever heavier inundations than when ancient Gaul was covered with forests? Did not the rivers remain frozen all winter, and do you wish to bring back these temperatures? What benefits should we gain from a Siberian climate? Are there now fewer marshes than when their drainage was obstructed by forests? Did this constant humidity bring permanent insalubrity; and finally what policy can be justified, that gives preference to the oak before grain, and that would compel us, by restoring the condition of our ancestors, to seek our living in the woods?" The golden mean in this as in all things, lies between the extremes, and is founded upon reasons justified by fair induction from conceded facts.

had for expropriation, on the ground of public utility, observing the formalities prescribed by Title II and following, of the law of May 3, 1841. The proprietor expropriated in the execution of this article, has the right to regain possession of his property after reboisement, subject to payment of charges for expropriation, the cost of labors in principal and interest. He may relieve himself of the price of the labors by relinquishing half of the property. If the proprietor wishes to obtain repossession, he should make a declaration to the subprefect within five years after notice that the work of reboisement has been finished under penalty of forfeiture of this right.

8. If the communes or public bodies refuse to execute these labors upon their lands, or if they are unable to do it, the State may acquire either by amicably obtaining a part of the lands which they will not or cannot replant, or by assuming sole charge of the work. In the latter case, it will retain the care and use of the lands until it is reimbursed its advances, in principal and interest. Nevertheless the commune shall enjoy the right of pasturage on the lands replanted as soon as it is found beyond risk of injury.

9. Communes and public bodies may in all cases exonerate themselves from repayment to the State, by relinquishing one-half of the replanted lands. This abandonment should be made under penalty of loss of right of doing so, within ten years from notice of the completion of the works.

10. The sowing or planting cannot be made on more than a twentieth in one year of the surface to be planted, unless a resolution of the municipal council authorizes it to be done to a greater extent.

11. Forest-guards of the State may be appointed for the care of the sowing or planting done within the boundaries fixed by imperial decrees. Injuries proved by these guards, within the extent of these limits, shall be prosecuted in the same manner as if done in woods subject to forest regulation. The execution of sentence is to be in accordance with articles 209, 211, and 212, and paragraphs 1 and 2 of article 210 of the Forest Code.

12. Paragraph 1 of article 224 of the Forest Code is not applicable to reboisement done with aid or premiums from the State, in execution of the present law. The owners of lands replanted with aid or premiums of the State may not pasture their cattle without special license from the forest administration, until the time when such woods shall be recognized by said administration as sufficiently protected.

13. A regulation of the public administration shall determine (1) the measures to be taken for fixing the boundaries indicated in article 5 of the present law; (2) the rules to be observed in preservation of works of reboisement; (3) the mode of determining the advances made by the State, and the measures proper for assuring repayment of principal and interest, and the rules to be followed in the relinquishment of lands which article 9 allows communes to make to the State.

14. The sum of 10,000,000 francs is appropriated for paying the expenses authorized by the present law, to the extent of 1,000,000 a year. The minister of finances is authorized to sell, with right of clearing, if necessary, woods belonging to the State, to the value of 5,000,000 francs.

These woods may only be taken from such as are entered in Table B, appended to this law. The sales shall be done in succession, within ten years from January 1, 1861. The minister of finances is likewise authorized to sell to communes, upon approved valuation, and on conditions fixed by a rule of the public administration, the woods hereinabove mentioned. The 5,000,000 francs needed to complete the expenses authorized by the present law shall be provided by means of extraordinary cuttings, and, if necessary, from the ordinary resources of the budget.

A law was enacted the same day, providing for improving the commons by aid from State in the way of drainage and the like, so as to bring them under agricultural or forestal improvement. A circular was also issued for carrying the law of reboisement into effect, and afterward, from time to time, other regulations as occasion arose.

On the 8th of June, 1864, a law was passed for the sodding (*gazonnement*) of mountains, as a concession to the inhabitants of mountain-regions, whose chief interests had formerly been involved in pasturage, and who could not see the works of reboisement undertaken without serious apprehensions of ruin to these interests.

In putting these measures into effect, and to gather all the results of experience possible on a new subject involving many interests, the happy thought was conceived of calling annual conferences of the agents intrusted with these labors, to be held three days or so at a time, at convenient points, for the discussion of questions relating to this enterprise. The first of these meetings was held December 9, 10, 11, 1861, at Valence,

in the region of the Alps—at Aurillac, for the mountains of Central France, and at Tarbes for the Pyrenees.

The various points of discussion and statements of conclusion or of doubt, were carefully reported to the central office.

The opinions of the administration were added to these reports by way of remarks, and then published. Although specially relating to reboisement, these questions involve principles affecting the rights of property in woodlands, and the duty of government in the exercise of its right of eminent domain to control these rights, where they concern the public welfare. They more frequently, however, state difficulties arising in management and cultivation, that are likely to occur elsewhere, and may therefore serve a most useful purpose in this country, by suggesting ideas applicable with us, either in applying laws that the general or State governments may deem it necessary to pass in respect to timber-planting, or by aiding in the solution of difficulties that may arise in individual experience.[1]

Dispositions manifested by the population.—The inhabitants of mountain districts, being much engaged in the interest of pasturage, do not welcome, in general, the measures of reboisement, but look upon them with much apprehension. Yet the personal proceedings of the agents, with the concurrence of the prefectoral authority, have overcome much of the resistance of the municipal councils. In many cases, communes have voted aid for replanting denuded mountain-lands. In the arrondissement of Saint-Girons seventeen communes had given up a twentieth part of the price of fellings sold in 1860 and 1861, or the proceeds of damages and fines, to be used for this object. There has been occasion to remark that on many points the mass of the population is favorable, and the opposition comes from the more or less influential members of the local administrations having a personal interest in preventing pasture-lands from being diminished.

There is reason also to acknowledge, that the rapidity of success of the works, has had a good effect in bringing the communes to enter upon the scheme. This result is notably the case in the *Puy-de-Dôme*, where important works have been done for some years under a provision of the forest code, and where opposition is now rarely shown and is easily overcome.

As for private parties, they generally hesitate about undertaking works of reboisement, the fruits of which they can only reap after long delay. They dread the expense and the difficulties of surveillance, and are kept back from ignorance of the means that should be employed to accomplish conveniently the replenishments. Many, especially in the Loire, have shown a desire to see the direction of the works of reboisement intrusted to the agents of the forest service, and the example in this matter is found to be contagious. The fact has been established in the Ardèche, where some persons have been asking aid on the invitation of forest agents, and these have been speedily followed by many proprietors. The number of requests in this department amounted to 365 in 1861.

REMARKS.—The report given of the state of mind in mountainous regions relative to reboisement indicates the means to be employed to enlist the sympathy of the population in the operations. To multiply the personal proceedings, to make a good selection of ground for first experiments, in order to arrest the eye—to convince the indifferent and the incredulous, and to call in the conjoint action of the prefectoral authority at all times when resistance, resulting from personal interest, is shown in the municipal

[1] We have generally adopted the translation given by Mr. J. C. Brown in his admirable work on Reboisement already cited in presenting these points of objection and reply.

councils, are the general means to be employed by the agents. The administration, on its part, will support their proceedings, and will be liberal in encouragement whenever the general interest may appear to demand the powerful concurrence of the State.

To act on such minds, too much cannot be done to diffuse information of the advantages realized by reboisement. The commune of Bourg, Lastic, in the Puy-de-Dôme, has a piece of 64 hectares covered with heaths, which they could not sell in 1834 for 7,000 francs. At this time a sowing of Scotch fir was undertaken at the expense of the commune, with aid from the departmental treasury, and which was not great. To-day the ground is worth 70,000 francs, and the commune begins to realize products which in a few years will be considerable. The commune of Durtol, in the same department, on 67 hectares planted with Scotch firs some fifteen or seventeen years before, lately got about 16,000 francs from thinnings. Such cases are of a character to remove hesitation.

As regards proprietors, the applications for aid which have been made successively in the Ardèche, are an indication of what will occur most likely everywhere wherever the like has been given. The administration will agree, moreover, to cause the work of reboisement to be directed and superintended by its agents, or by special overseers, whenever a certain number of private proprietors resident in the same district shall express a desire for this, and the measure shall appear necessary to the success of the works and to their development.

Sanctioned reboisements.—The opinion was expressed that no applications for subventions should be entertained, which are made by private proprietors for the planting of small, widely-separated pieces of land, and which would require the administration to expend money unprofitably, without the possibility of superintending and controlling such widely-scattered replenishings.

REMARKS.—Certain rules must certainly be observed in the allocation of subventions. The reboisement of a territory which is not attached to any similar operation completed or to be undertaken, in most cases will be of no advantage to the general interest, and willnot be of a nature to be encouraged by the State. It will, therefore, be well, in case of requests for aid, to find out in what way the proposed reboisement is related to the public interests, and to keep this relation in view when grants of money, seed, or plants are in question. Of course, at the beginning of the enterprise, operations aided by the State will be much apart. It cannot be expected that all proprietors in a given area will resolve to effect these plantations contiguously. But it is necessary to prevent the distances from being so great as to make the control of the aid and the superintendence of the work too difficult.

It was proposed that rewards should be given to communes or to private owners who should be the first to inclose their lands.

REMARKS.—The law regarding mountain reboisement limits its operations to this work strictly. No portion of the funds can be employed as premiums to proprietors who take the initiative in the inclosure of the whole or a part of their estate. But this can always be done, as regards communes, by appealing to the law concerning bringing in the waste communal lands. The proposal can be made at the proper time to the superior commissioner charged with presiding over the combined operation of the aforesaid law and the law of reboisement.

Questions relating to forest improvement have remained till now, and especially in the South, too much confined to a narrow circle. It is very important to make them known in every possible way. A periodical has just appeared under the title of *Revue agricole et forestière de la Provence.* Everything relating to forests, and especially questions on the reboisement of mountains, are to be therein treated of, with the necessary developments. An appeal has been made for help from those who wish to popularize forest science.

REMARKS.—Government cannot hesitate to encourage the enlightenment of the popular mind respecting questions connected with the prosperity of the forests. A grant of 500 francs is made in aid of this journal. It is desirable that the employés should lend their helping hand to this work of enlightenment.

Obligatory reboisement.—Important plantations have been made in certain departments, especially in the *Puy-de-Dôme* and in the *Haute-Loire,* with the help of the enactments in article 90 of the Forest Code.

Those employed have inquired if they may not continue to proceed in the same way wherever it is possible. Government will thus possess an additional means of carrying on mountain reboisements.

REMARKS.—The law of July 28, 1860, has not abrogated any of the enactments of the Forest Code, and there is nothing to hinder article 90 from being applied wherever the means of reboisement can be advantageously employed.

The agents employed have usually agreed upon the best way of finding out where compulsory reboisements ought to be effected. For example, suppose a river, resembling a torrent like the Durance, the flow of which it is necessary to restrain ; the first thing done is to study the whole basin, beginning at the source of the stream, attentively following its course, either on the spot or on a map furnishing sufficient details of the principal and secondary tributaries,and, after this preliminary study, operations are projected at different points in the basin in the order of urgency. They have proceeded in this way in the *Basses-Alpes*, in the *Hautes-Alpes* in *la Drôme*, where all the operations, either projected or in course of execution, aim at regulating the flow of the Durance and its tributaries, such as the *Ubage*, the *Bléone*, the *Asse*, the *Buecl ;* in *la Drôme*, *l'Aigue*, *l'Ouvers*, and *le Bez.*

REMARKS.—It is necessary to concentrate operations in reboisement where they are only sanctioned; it is still more important where they are declared to be of public utility. Isolated observations should not be made, but all should be connected with a plan of operations converging to the same end. It is very essential to demonstrate by facts, the advantages of these operations. It is necessary, where the examination of a given area is determined upon, that it should be pursued through all parts of the area where the rush of water is to be restrained, so that when it is finished the proof of effect should be conclusive.

A question has been raised as to the relative importance of reboisement and gazonnement for the consolidation of the soil, and the creation of obstacles to the sudden overflow of streams. Several engineers, especially in the Alps, appear disposed to think that *gazonnement* is often the most suitable means of attaining the proposed end. Other experts are of the opinion that if in certain cases *gazonnement* may appear enough, reboisement will move slowly, but more completely and durably effect a result.

REMARKS.—There appears to be attributed to *gazonnement*, especially in the *Hautes-Alpes*, in *l'Isère*, and in *la Drôme*, a power almost as great as that of reboisement for resisting torrents. This is a little exaggeration. The administration does not deny the utility of restoring the turf, but works of this kind should be undertaken on the vast bare surfaces which extend above the region of forest vegetation. Executed simultaneously with planting, they give powerful aid in hindering the rush of torrents into the valleys. In order to seek this result by a double means, the administration has promoted the formation of a higher commission for the simultaneous execution of the two laws on reboisement and reclaiming of waste communal lands. But everywhere where planting is practicable, the latter seems to promise to be the most efficacious means. The employés are mistaken if they think themselves obliged everywhere to propose immediate reboisement with valuable trees. When the soil is nearly exhausted, and requires to be renewed before being fit for the production of forest trees, it should be planted with bushes or hardy shrubs, such as grow here and there on the barest part of the mountains. This work is included in the category of planting, properly, so called, and constitutes a real reboisement. The circular No. 806 contains on this point, pages 7, 8, all the necessary hints. According to this circular the examination of ground for compulsory reboisement should include grounds to be reboised, either with permanent trees, or with preparatory plantations, and grounds on which it is necessary to carry out works of *gazonnement.*

The replenishing with woods may be effected through the operation of the law for bringing in the waste communal lands. These undertakings should furnish all necessary hints; and those of them which include operations belonging to both categories will be handed over to the high commission appointed by the decree of November 7, 1861.

In the *Haute-Loire*, the employés intrusted with the survey of districts for determining what should be done for compulsory reboisement, have declared that they are often at a loss, on account of the peculiarities of the soil, consisting of waste pasture, partly wooded, but forming no greater obstacle to the torrents than if they were entirely bare. They have asked the conference to decide whether districts of this kind, which do not cover less than 65,000 hectares, in the department may be included in the obligatory limits. The employés assembled at Aurillac did not hesitate to answer in the affirmative, at the same time referring the question to the administration.

REMARKS.—The principal object of the law of July 28, 1860, is the creation of barriers to the sudden descent of torrents into the valleys. There is no doubt that districts sparsely covered with trees, having no hydraulic effect, should be included in the extent to be replanted when there is an opportunity for fixing an obligatory limit of enjoined reboisement.

The form to be given to enterprises of compulsory reboisement has been the subject of a detailed examination. It has been acknowledged that up to this time these enterprises differ very slightly, and that experience will supply the most useful indications for the simplification and modification of these projects.

REMARKS.—It does not seem that the proper time has come for prescribing a determinate form to enterprises of compulsory reboisement. The number of those examined by the administration up to this date, is not large enough to enable one to decide on the best form for these undertakings. On the other hand, no great difference has been observed in the plans presented by the officials of the different districts. The only remark that there is any need to make is, that some officials have assigned too long a time—ten or twenty years—for the completion of the work. The administration has pointed out that such a delay is incompatible with the rapidity which, from every point of view, is seen to be very desirable. It has just repeated that, when reboisement with long-lived trees is not immediately possible, the ground can be stocked with shrubs of an inferior order, an operation which can almost always be effected at once, and which is really included in the category of reboisements, properly so called.

It should be added to the instructions given, (1) that when a proprietor has several pieces of land in the perimeter, these pieces may be grouped together, if they fall under the application of similar measures; (2) that it is not necessary to point out the subvention to be allotted to each piece, but that those pieces may be grouped together for which the same proportionate aid is proposed, and the importance of each group may be known by the proportional per cent. of the expense; and (3) that pieces may be grouped together, the value of which has been fixed by their yielding the same yearly amount.

Various observations have been made upon the apportionment of governmental aid for works of reboisement. One employé has expressed the opinion that it will be difficult according to circumstances and according to locality to grant aids of variable importance and to absolve in certain cases the communes from all expense on account of considering, as a direct participation in the expense of the reboisement, the apportionment of aid from the treasury of the department. He has, in fine, requested that a maximum be fixed, for example, say 80 per cent. of the expense for the communes and 60 per cent. for private individuals, a maximum which must not in any case be exceeded in the offers of subventions from the state or from the department.

REMARKS.—The aid is in its very nature variable. It depends on the importance of the restocking with regard to the public interests and the attitude of the public mind in the district with regard to mountain reboisement, the more or less easy position of the proprietors, and on various other analogous circumstances which it does not appear necessary to detail. From thence it follows, that the administration should specially

[1] This article is as follows: "There shall be submitted to forest regulation under article 1 of this law such coppices or high forest owned by communes and public bodies as may be recognized as susceptible of *aménagement*, or of regular working by the administrative authorities, upon the advice of municipal councils or of the administrators of public bodies."

reserve the power of taking into consideration on each demand, the amount of the subvention to be granted. A maximum cannot, therefore, be fixed. As regards the communes, the administration intends, where required, to consider the subventions voted by the general councils of the departments as a direct participation in bearing the expense of the works.

Several employés have given an opinion that aid should be offered in preference to proprietors whose lands are included in the perimeters, so as especially to encourage reboisements of acknowledged public utility.

REMARKS.—The law grants aid in cases of sanctioned as well as in compulsory reboisement. The administration will proportion in both these cases the amount to the expected result of the enterprise, regard being had principally to the public interests.

Method of carrying on operations; nurseries.—Differences of opinion were expressed in regard to the extent that should be given to nurseries. It was agreed that this should depend on the yield, and the extent to be planted. There was also a difference of views as to great central nurseries or many small one scattered here and there where they are most needed.

REMARKS.—The chief effect of the former, in close proximity to great populous centers, is to attract public attention, and induce the owners of waste mountain lands to plant by the facilities offered for supplies. Such nurseries can also be more cheaply taken care of. Still nothing is fixed, and no preference is expressed for either.

Difference also arose as to whether the soil, elevation, climate, &c., of nurseries should be the best possible, so as to grow the most healthy plants, or such as the trees should have when transplanted, so that too great changes would not be required. Some, from the same view also, thought that the soil should not be manured, but, where necessary, the soil should rather be pulverized and vegetable composts used, especially such as come from the woods.

REMARKS.—If the nursery can be placed where the soil is good, and at a moderate distance from the district to be replanted, it will evidently be of advantage to the State to become its owner. There are almost always dangers in fixing the position of a nursery, if care be not taken to stipulate in the leases the guarantees necessary to protect the interests of the State. There is reason to believe that in most cases the purchase is of greater importance than the situation, since the State can always, when necessary, sell the land which has been improved by culture when it becomes useless as a nursery.

It is agreed that the ground of a nursery should be always thoroughly pulverized at least 30 centimeters (about a foot) deep. All are not agreed as to the quantity of seed needed. As to pine, the opinions agreed upon 8 to 10 kilograms per hectare (8.8 to 10.7 pounds per acre).

Sowing the whole nursery and extracting the plants from a third of the whole at the end of two years, with an immediate resowing of the ground, and so on for the other two-thirds, appeared to some an economical plan, yielding satisfactory results. By this system, the plants would be used without being first planted out.

Others thought that with regard to nurseries there should be less thought of the expense, than of the benefit to be expected, and that it was above all things necessary, especially at the beginning of a great enterprise, to employ all possible means to insure success; and that, with this in view, the ground should be divided into strips, which should alternately be sown and left unoccupied; that the young trees should be planted out carefully, to allow of a proper development of the root; and finally, that the sowings should be graduated in such a way as to obtain a difference of age favorable for transplanting.

REMARKS.—The idea underlying this suggestion is a sound one. Attention should be given primarily to the efficiency of the nursery, and the question of saving expense should be secondary to this.

For stocking the nurseries, it has appeared right to employ as much as possible seed grown in the locality, or in the immediate neighborhood. It has been thought good to employ shelter of every kind—branches, stretched out cloth, straw quilted between canvas or cord, fern, and screens of arbor-vitæ. Some were of opinion that the plants should be watered, but with caution; and it was thought that, although in certain localities indispensable, there was in most cases the inconvenience of accustoming the plants to a moisture that would not always be maintained, and of thus making them more sensitive to the action of heat.

Other operations, such as weeding and hoeing, were considered by every one as indispensable. All were also unanimously of opinion that the nursery should be inclosed, and that nurseries of any extent should be provided with a hut as a shelter and tool-house.

REMARKS.—There have been recommended as sufficient and economical fences, either simple ditches, wide enough to present obstacles to the incursions of animals, or parallel lines of wire fencing, fixed at regular distances to wooden posts. As a useful precaution in transporting, it was recommended to cover the roots with a mixture of clay and cow-dung.

Opinions were quite various as to the season for sowing, mode of culture, and several details as to keeping in proper order:

REMARKS.—Experience alone can provide useful hints as to what is most suitable to each locality.

Choice of trees.—The employés have not been able as yet to submit well-prepared returns as to the kind of trees to be used in mountain reboisement. Up to this date, the trees principally used have been the *épicéa* or Norway fir, the Scotch fir, the black Austrian pine, the Aleppo pine, Corsican pine, and the ailantus, which have generally succeeded; the larch, which has failed sometimes because the ground was too damp and the elevation too low; the acacia, which has failed when planted at too great an elevation, but has succeeded lower down. The Atlas cedar has been used in several districts.

Deciduous trees, such as the white oak, the green oak, the liege oak, the chestnut, the willow, the white poplar, and the birch, have been successfully planted in the several places; shrubs, such as the amelanchier, sumac, hazel, &c., have afforded good results in preparing the soil for a stock of valuable trees.

REMARKS.—It is well to attend to the indications supplied by nature in each locality, especially where there is any question of replanting with shrubs or inferior vegetation. There is nothing to hinder a trial of new kinds of trees when this is made with requisite caution. Thus, the ailantus, recently tried in several places, has everywhere yielded good results. The same may be said of the Austrian pine, which almost always succeeds in calcareous soils, and at the most varied altitudes. It will be only after a number of experiments that it will be possible to classify with any degree of precision the kinds of trees by regions and by zones of altitude.

In Germany, a mixture of Norway firs and larches is generally considered a good one. A mixture of oak and Scoth fir is also recommended at points where the former has a chance of success. One cause of failure in sowing larches is having the seed placed at too great a depth. This seed should be covered very lightly with earth.

Mode of execution of works of reboisement.—After preparing the ground, (in doing which, especially on the slopes, great care should be taken not to disturb the soil too much,) it is necessary to proceed with the work of restocking with trees. Opinions are divided as to whether sowing should be preferred to planting, or *vice versa*.

Many are inclined to think that sowing should be employed, as more economical in temperate districts, where success is sure, but that planting is to be preferred at greater altitudes.

There is, moreover, a mode of sowing, known as sowing on the snow, which has several times been employed successfully, and which will facilitate the stocking of large surfaces at the small outlay of from 25 to 30 francs per hectare.

Sowings of larch-seed on the snow have several times succeeded in the *Hautes-Alpes* and in the *Basses-Alpes*, and it is proposed to make similar experiments in these districts with other seeds.

When the ordinary mode of sowing is employed it is advantageous to sow early, that is, at the beginning of spring, so as to avoid the too sudden effects of the summer heat.

Sowing by means of pockets has appeared most suitable for clothing uneven surfaces or friable soil. The quantity of seed to be used is calculated, on an average, at 3 hectoliters of mast per hectare, at 6 or 8 kilograms of Scotch fir or other similar seed, and at 6 kilograms of larch. This quantity might be doubled when the sowing is done in strips. These quantities are, besides, essentially variable, according to circumstances and locality.

REMARKS.—The administration thinks it proper to recommend the sowing of seed upon the snows. Although its succees has not yet been tested in a sufficient number of places, there is sufficient reason to employ it with different kinds of seeds, and in different places, where it may be likely to succeed. It is not necessary to enlarge on the advantages of so simple and economical a mode of restocking.

On volcanic soil, covered with scanty heath, good results have been obtained by sowing broadcast, without any further preparation than a simple digging the surface herbage up, and burning off, where the long thistle-heath hinders the seed from reaching the ground.

The necessity for early sowing cannot be too much insisted on; in March, for example, when they can profit by a few fine days, often very soon followed by snow and rain. Germination then takes place under favorable conditions, and the young plant is able to resist the great heat which would have killed it if the sowing had been deferred until the last snow had melted.

It is desirable to form artificial shelter wherever it is possible. When planting is the mode chosen, the season selected is not the same in every district. Opinions are not agreed on this point. In Provence it has appeared that, almost invariably, planting in autumn is to be preferred, because of the early season of the droughts, and on account of the scarcity of workmen, who are resuming their agricultural employments.

The age at which plants should be used is very variable. In the high regions of the Drôme and the Isére, it has been remarked that plants should be strong in proportion to the elevation of the district. It is good at such points only to plant trees which are four or five years old at the least.

The quantity of plants per hectare is necessarily variable. Only strictly local indications can be given on this point. The expense of the stocking per hectare has not yet received a sufficiently approximate calculation. Experience alone can furnish the data necessary.

Several employés have considered the question whether the mode of working by contract might not be advantageous and economical for the preparation of the soil; without being quite decided, they are inclined to think that this mode of proceeding may be useful.

REMARKS.—It does not appear that there are as yet sufficient grounds for throwing open the operations to private speculation. It is only after they have been carried on economically, that it will be advisable to substitute contract for government management.

A scarcity of workmen in certain districts, and especially in the Alps, has engaged the attention of the agents, who have expressed a wish that the administration would interfere and obtain from the minister

of war the paid assistance of military workmen when circumstances permit.

REMARKS.—The administration will most willingly negotiate this matter with the minister of war when it becomes necessary. But to do this, it must be able to specify and define the proposal, and let him know the situation and extent of the operations, their duration, the time when they will take place, the number of workmen required, the point from which they should be sent, the pay which they will receive, &c.

Several employés are of opinion that the special staff of the reboisements should be in keeping with the increasing development of the operations, and that the employés composing this staff be intrusted with the execution of the enterprises which they have suggested, with the assistance of the local employés during the disposable time left to these latter employés by the requirements of their ordinary duties.

REMARKS.—The administration proposes to intrust special agents with the work of reboisement, not only in what regards the preparation for the undertaking, but also the execution. This service will also be placed in due time in position to grapple with new exigencies as they may arise. The employés of the ordinary service should not, however, consider themselves relieved from all participation in the operation in question.

Negotiations with proprietors of waste mountain-lands, for the purpose of engaging them in reboisement, the giving due notice in regard to demands for aid in sanctioned reboisements, the supervision of execution of operations of restocking, the giving of assistance in operations of required reboisement when they take place, will be a part of the functions and duties of the officials attached to the ordinary service. The administration has pleasure in believing that all the officials will assist the enterprise with all necessary zeal and devotion.

Such were the points raised upon questions of difficulty that presented themselves at the beginning of this enterprise.

A second conference of agents was held in 1862, on the 8th of September and the following days, at Clermont-Ferrand, for central France, at Carpentras, on the same days, for the Alps, and on the 15th and following days, at Foix, for the Pyrenees. Upon these occasions, the questions submitted for discussion related more to administrative details, but those of more interest to planters generally related to the execution of the works, and were as follows:

In what cases is it proper to proceed to the restocking of woods by planting, and in what by sowing?—According to the agents at the conference at Clermont, the sowing being more economical than plantations, making more certain the retaining of the land, and opposing greater obstacles to the flow of waters, ought to be preferred to plantations, in view of the object of the law of 1860; but when the works are at great altitudes on steep declivities, not well adapted for retaining the seed, and in certain soils, such as the chalks of La Bresse, or the calcareous schists of La Lozère, it will be necessary to have recourse to plantations.

At Foix, the agents expressed the opinion, that it is better to proceed exclusively by means of plantation in the elevated parts, and only to employ sowing in connection with planting, in the places of medium height, and low parts, where frosts are less to be feared.

At Carpentras, the agents were of opinion that plantation is preferable to sowing, looking, and looking only, to culture; but that, sowing being more economical, it is better to employ it when it appears to offer sufficient chances of success.

REMARKS.—Without its being possible to point out exactly the cases in which the one or the other of the two modes of procedure should be followed, it seems expedient to admit, as a rule, that plantations being subject to fewer destructive agencies than seed-beds, it is better to plant under vigorous and peculiar conditions of climate, locality, or soil. The essential point is, to insure the success of the reforesting of the

locality. The question of economy ought, undoubtedly, to be one of great consideration, but whenever success appears to be certain by one mode, and to be doubtful by another, there should be no hesitation in employing the former.

Discuss the kinds of trees selected, the mode of plantation, singly or in clumps, &c.; the number of plants per hectare; the season best for the execution of the work; the expense per hectare of restocking woods.—The agents at Clermont have experimented successfully with the larch in reforesting bare lands. The Norway pine and the pine of the country have given satisfactory results, and they appear to be such trees as should be employed in regions of medium altitude. The oak, planted but only to a limited extent in the Puy-de-Dôme, and in the Haute-Loire has succeeded well. The ash, whether planted in large clumps or intermixed with resinous trees, promises to succeed well in the Haute-Loire.

REMARKS.—The indications reported by the agents are based upon experiments actually made, and the administration has nothing to add to the contrary. It can only recommend to the agents carefully to note all the facts observed in the different regions, with a view of obtaining, when requisite, instruction from these. It is by continual experimenting, that the administration will gradually come to give the operation a greater and more satisfactory direction.

Hitherto the planting of single trees alone has been attempted and this has succeeded very well. It is only from next year, that the nurseries of Arpajon, of the Puy, and of the Mende, will present sufficient resources to permit of the experiment of planting thickets being made. In any case, this latter mode could not be at great altitudes, plants of three, four, and five years' growth alone succeeding under such conditions.

The number of plants ranges from 7,000 to 11,000 (2,834 to 4,453 to the acre), according to the conditions of soil, exposure, inclination, &c. The most favorable season is spring, in climates where the winters are very severe. In the middle or low-lying districts, autumn seems preferable, on account of its permitting the young plant to get strength to resist the great heats of summer. The spring seems to suit better for the plantations of resinous trees. There is reason to believe that plantations of these, when the sap begins to move, succeed more certainly. Broad-leaved plants seem to accommodate themselves better to the autumn planting.

The expense of carrying on the work of plantation amounts, for the hand-labor, to 70 francs, by the hectare, in the Loire; to 57 francs in the Haute-Loire; to 18 francs in the Cantal; to 38 francs in Puy-de-Dôme.

Seedlings brought from the depths of the forests and planted in various localities experimentally, with a view to determining the economical importance of such a procedure, have not given satisfactory results.

REMARKS.—The administration is aware that plants from the sources mentioned have no great value. But in order to avoid the expense of purchase it was necessary to try to derive some advantages from the resources offered by the forests, until such time as the nurseries shall yield plants.

The conference at Foix was of opinion that it is best to employ the indigenous products of the Pyrenees, such as the nugho, or dwarf pine, the Scotch fir, the birch, the silver fir, the ash, the beech, the oak, the evergreen oak, the great maple, and the chestnut, and to continue the experiments which have been made with plantations of the Norway pine, the Austrian pine, the acacia, the silver fir, the ailanthus, the larch, the pine of Aleppo, and the mountain pine. These kinds to be

distributed according to the altitude, to the local conditions, and to the results of experience.

The planting in separate holes, of plants transplanted from nurseries seems to offer the best chances of success. The planting in clumps is, however, preferable, when disposing of plants taken from a plantation near the lands to be reforested.

The number of plants on each hectare may vary from 10,000 to 2,500 (4,049 to 1,012 to the acre), this last number being applicable more especially to saplings, and to the chestnuts, if it be desired to obtain from them poles of good growth at an early age. The season of spring being almost unknown on the mountains, where great heat succeeds, almost without interval, to the cold of winter, the autumn is, in all cases, the most convenient season for planting. The price of hand-labor varies from 50 to 100 francs per hectare. The purchase of plants has cost 10, 15, and 25 francs per thousand.

REMARKS.—The minimum of 2,500 plants to the hectare appears very small. The reforesting of the mountains having especially for its object to cover the soil, independently of the addition of future produce, it is better to avoid planting the trees separately at great distances. The nurseries of the administration promise soon to supply plants at less expense than that at which at present they can be obtained.

The agents at Carpentras stated that they had employed on l'Isére, and the Hautes and Basses Alpes, the white oak up to 1,000 meters of altitude, the acacia up to 900 meters, in all exposures. The ailanthus had as yet given too little experience for deducing from its use any certain remarks. The Scotch fir, the Norway fir, the mugho, and the larch, have been employed with success in different situations. In the department of Vaucluse, of the Gard, of the Bouches du-Rhone, of the Var, of the Maritime Alps, and of l'Herault, there was reason to think that the trees which should be used principally were the white oak, the green oak, the acacia, the maritime pine, the Norway fir, and the larch—at all altitudes, and in situations pointed out by experience. The planting in holes, taking the precaution to disturb the soil very little, and to procure for the young trees natural shelter—such as bushes, rocks, and the stones which are found on the land—seemed to be the most suitable system of planting.

The mode of planting in clumps, which is very costly, should only be used for resinous trees, and in situations where to secure success is difficult. But this proceeding will always be most advantageous when it is not necessary to regard the question of economy. The best plants are generally transplanted plants of two or three years.

REMARKS.—The last-mentioned method has been made the subject of experiment with success. It is not well to attach too much importance to the expense which it occasions. In the first place, the plants being small, their price is not great; in the second place, the preparation of the soil is very easy; finally, as this process is almost always successful, it must be employed without fear in difficult situations, apart, in some measure, from the question of expense.

The number of plants per hectare to be employed varies from 10,000 to 16,000 (4,049 to 6,477 per acre), for separate plants, according to the conditions of exposure and soil, and the kind of tree, &c. For planting in clumps, the number would be 30,000, at the rate of 3 to a hole, and 10,000 holes per hectare. The planting in autumn is generally preferable, as giving time for the plants to be in a state to resist the spring frosts and early heats.

The cost of manual labor varies from 40 to 100 francs. The cost of plants varies too much to allow of an estimate approximately correct being made.

Discuss the choice of trees, the fitness of each mode of sowing (in rows, holes, open bed, &c.), the quantities of seed to be used per hectare, the fit season for carrying on the works, the expense of the work per hectare, &c.— The agents at Clermont reckoned that in the central region, wherever the climate is mild and the altitude a medium one (800 meters and under), the oak and chestnut should be employed in preference to every other tree, and if the soil is of poor quality, the resinous trees, the acacia and ailanthus.

In the regions where the climate is more severe and the altitude greater, recourse should be had to the Scotch fir, the Austrian pine, the Corsican pine, the mountain pine, the Norway fir, and the larch. The Atlas cedar, the larch, and the Siberian cedar can be used for the greatest heights. No tree, except perhaps the fir tree and the beech, ought to be rejected in so far as the sowings are made *in loco.* The least costly and most simple method of sowing, practiced for a long time in the Puy-de-Dôme, is sowing at random on short heath, or after cutting up with spades and burning, if the heath is too high. But this system is not practicable everywhere. The method of sowing most usually employed is in rows, or in holes dug according to circumstances. In both cases much disturbance of the soil is to be avoided.

The quantities of seed necessary are, for the oak and chestnut, 6 to 10 double decaliters (1.28 to 2.14 gallons to the acre); for resinous seeds of small size, 10 to 12 kilograms (8.8 to 10.7 pounds to the acre) on ordinary land, and a third more if the conditions are unfavorable. For the Austrian pine, 12 to 15 kilograms (10.7 to 14.3 pounds per acre). For the maritime pine, 20 to 25 kilograms. The most favorable time for sowing should be as early as possible in February or March. The cost of hand-labor is, for sowing in bands, 30 to 35 francs per hectare; and for sowing in holes, 25 to 30. Reforesting in resinous seeds costs on an average in central regions 70 to 80 francs per hectare.

At Foix the members were of opinion that the choice of trees depending essentially on the nature of the land, and on its exposure and altitude, no decisive rule can be given under this head. At the same time it may be concluded, that in elevated regions there will be used with success the Norway fir, the larch, and the black Austrian pine; in the regions of middle altitude the pine, the Norway fir, the beech, and the pine and beech together, and in lower regions broad-leaved trees in general, the chestnut, the green oak, the ash, and the ailanthus.

The method of sowing in holes seems to be most advantageous. The quantity of seed to be used is from 10 to 15 kilograms per hectare. Spring is generally the best season for sowing, especially for resinous seeds. The expense can be approximately and in a general way reported at 100 francs per hectare—*i. e.*, 60 francs for hand-labor, 36 for seeds, and 4 for unforeseen expenses.

At Carpentras the agents estimated that for sowings, the trees to be preferred are generally the same as those pointed out for planting, with the additions of the Corsican pine, the cedar, the Aleppo pine, and the shrubs intended for the preparation of certain soils, or for preventing the erosion of hill-sides, such as the *argoussier*, the *amelanshier*, the barberry, the juniper, &c. In l'Ardèche the sowings of Norway fir do not offer sufficient chances of success. Sowing by bands is preferable whenever it can be employed, but it has the inconvenience of loosening the soil too much on the slopes, the method of sowing in holes will be more generally employed. Complete or full sowing is the only method possible on rocks, on ground difficult of access, stony parts and volcanic scoriæ. The quantity of seed to be employed per hectare, is from

7 to 10 kilograms for resinous trees, and 3 to 6 for oak. Opinion was much divided on the choice of season. The result appeared, however, to be generally that for resinous trees and in friable earth spring ought to be preferred; while autumn appears to suit better for the oak. The cost of labor may be estimated at 60 francs per hectare for sowing in bands, and 35 in holes. The price of seeds being approximately on an average 3 francs per kilogram, the cost will be from 70 to 100 francs per hectare.

REMARKS.—The quantities of seeds mentioned by the agents at Clermont will require to be increased, in so far as the larch is concerned, the seed of which generally succeeds only in the proportion of 40 to 50. Sowing in holes or drills seems generally recognized to be the most advantageous.

In respect to sowing on the snow, the agents of the central region had made no experiments, and all on the Pyrenees had failed. This method was introduced in the Alps some fifteen or eighteen years ago. It was tried in the department of the Basses-Alpes on a calcareous soil, for a long time unused and covered with grass, and with a northerly exposure. It succeeded perfectly. The experiment was renewed in 1862 in the same department on 200 hectares, and in the Hautes-Alpes on 40 hectares, with fir, larch, cedar, Norway fir, and Scotch fir. The fir did not succeed; the larch succeeded only in part on grass lands, and with a northerly exposure; the cedar did well; as to the Norway fir and Scotch fir, the result has not been established. There were used from 6 to 8 kilograms of seed per hectare. The manual labor cost only 2 francs. An attempt made in la Drôme, at 700 meters altitude in limy soil, and in a northern exposure with the maritime pine, and succeeded to a limited extent. The sowing should be made on soft snow, and in a settled temperature, in order to avoid the floodings caused by the southerly winds and warm rains.

REMARKS.—The sowing on snow is very economical, and for this reason one might be tempted to employ this method for the reforesting of large surfaces; but experience in this matter gives reason to conclude that the results, always uncertain, are generally unsatisfactory It does not appear that there is any reason for classing this kind of sowing in the category of regular modes of reforesting. But it may be considered as an expedient capable of being employed with success in certain cases. The attempts made up to this time are, however, too few for a certain deduction to be drawn on this point. It might be useful to try further experiments, when the conditions shall appear more favorable. Manual labor being at a very low price, there would be no difficulty of increasing the quantity of seed sown, which appears to have been too small in the attempts made in the Basses-Alpes.

Nurseries.—It is desirable to discuss the processes of extracting and packing the plants, as well as the precautions is to be taken at their dispatch and receipt, in order to insure their growth; to study the method of sowing adopted in the nurseries (bands or holes), the quantity of seed used per hectare, the means used for protection, the expenses of the works. The system of repeated transplanting may be discussed. As soon as the beds produce plants fit to be used, it will be important to have kept, by the official specially charged with the nursery, a register, in which shall be inscribed the number of disposable plants and the numbers sent off. The conference is to consider the plan that should be adopted in keeping this register, of which an abstract should be periodically addressed to the administration, that it may know the number of plants ready for use.

Answers.—At the conference at Clermont very circumstantial details were presented, taking, for example, the nursery at Arpajon, the creation of which had been done with great care, and the state of which

was very satisfactory. The following details will serve as useful indications of the mode of its management:

Before being sown the bed should be prepared by clearing the ground and mixing the natural earth with heath mold of leaf trees, and in adding to the soil some kind of manure. The ground is then carefully broken up. [1] The ground may then be divided into beds, a meter in breadth, raised above the level of the ground, and separated by footpaths; and the beds about 8 to 10 meters long must be surrounded by sheltering screens or fences of Chinese arbor-vitæ. While these shelters are growing to a convenient height their places are supplied by artificial shelters, either formed of straw or of osier, or hazel lattice-work placed nearly vertically, or linen stretched over boards. The sowing is done in the first half of April, or later, if possible, in moist weather. It does not seem necessary to cover the seeds with earth; it is enough to pass the roller over the bed after scattering the seeds, and it is covered with moss, reduced to small pieces, and watered. The quantity of seed to be used per hectare is 12 kilograms per hectare; 12 for pines with small seeds; 15 to 18 for larch, Norway fir, and black Austrian pine; 26 to 30 for fir; 1 hectoliter for oak, and 6 double decaliters for chestnut. The seeds gathered in the country have given much better results than those obtained in the markets. The beds must be usually watered daily until the plants have gained some strength. After the first year the plants can be used. They cost 1 to 2 francs per thousand, are easily dug up, and are removed at little expense. But the chances of such young plants taking root being necessarily limited, it is only prudent to use them in moderate conditions of soil and altitude.

REMARKS.—The lifting of such young plants in the way described, is employed with advantage in planting in tufts. The earth raised is divided into clods containing each a certain number of plants, and these plants are conveyed in the clod to the place where they are to be planted; fragments containing two, three, or four plants, to be put into the place together, are broken off, and at least one of these always grows.

To obtain hardier plants more likely to take root under severer conditions, it is necessary to wait nearly three years, and to have them transplanted. The design of this operation is to place the young plants in circumstances favorable for the development of the fibrous roots. It is employed for plants of a year old, and should be done in spring, in order not to expose the young plants to the risk of being raised out of the ground by the frost.

It has been attempted to avoid the expense of this difficult and costly operation. As regards the oak, one agent has mentioned a process which may not be uninteresting to bring under the notice of the agents. This consists in artificially causing the acorns to sprout in winter, to cut off the radicle and sow in the seed-bed the acorn thus mutilated. It has been remarked that the loss of the radicle leads to the formation of lateral roots, while it prevents the formation of a descending taproot.

REMARKS.—Transplanting does not always appear to be necessary. In the nurseries it is practiced at different periods of the plant's growth. If when the plants are required, the best and most fibrous-rooted alone are made choice of, the removal of these will have the effect of relieving the others, and so favoring their development. In this way, plants of different stages of development may be successively removed, and this kind of periodical thinning has, for its result, to permit the plants of inferior growth to acquire sufficient strength. This removal is facilitated by the arrangement of the plants in rows on the beds. When it is necessary to thin the plants, there is

---

[1] Remark of Administration: If encumbered with weeds, it may be well to raise on it a crop of potatoes to secure their destruction before appropriating the ground to the growth of forest seeds. Too much digging or displacement of the soil should be avoided.

dug along the row a hollow into which the plants are turned; the proper choice is then very easily made, and the plants remaining are easily readjusted. Finally, the operation of transplanting can sometimes be replaced by cutting off the root in the ground by the use of the spade used at Hagenau (coupe-pivot), which ends in a diamond-shaped edge. The cutting of the root has for its effect to favor the development of a fibrous root. This economical and beneficial operation, however, can only be practiced in the earths into which the edge of a spade easily penetrates. It has not been attempted in the case of resinous trees, and it would not be without interest to make some attempts in this direction.

The sowings in the nurseries are exposed to injuries by rats, field-mice, mole-crickets, moles, birds, &c. The methods employed to combat these enemies have succeeded but imperfectly, and it will be necessary to devise others more efficacious. To prepare the plants for sending away, a dry day must be chosen; the digging must be with a spade; 100 plants are united in one clod; the roots are immersed in a bath of well-tempered, clayey earth, and they are covered with dry moss. They are then packed in layers in a box with open bars, the spars of which are covered with dry straw. A rapid conveyance is chosen, in order not to leave the plants for more than five, or at most seven, days in the boxes. On arrival, the plants are immediately unbound and assorted.

REMARKS.—It is by the spongioles, or the extremities of the fibers, that the roots draw from the earth the nourishment of the plant. It is, therefore, in the highest degree necessary to protect these delicate organs. For this purpose the bath of tempered clay is a very useful precaution. Before putting the plants into the earth it will be well to leave them nearly twenty-four hours in urine. This operation has the effect of singularly reviving the vegetative power of the plant.

To show the importance of the services that the nurseries are expected to render, the conference at Clermont cited the results of the nursery of Arpajon, formed scarcely two years before. It appeared that it would contain 32,489,000 plants of various kinds, worth 159,622 francs.

At Foix, the agents considered the operation of transplanting too expensive and requiring too much land. Watering should be practiced with moderation on account of the expense. The agents have unanimously expressed the opinion that it is advisable to diminish the sheltering fences as soon as the plants acquire strength, and that they should be low, so as to expose the plants to the light. The transplanting, which appears to the agents at Carpentras indispensable for the oak, is considered less necessary for pines and the Norway fir. Watering, if it is not indispensable, is at least useful to the resinous trees, and it must, when once begun, be assiduously continued.

Seed from the government drying-houses having been found much superior to that from the merchants, four of these were established in 1861, and two others in 1862. The supply from these was 15,000 to 20,000 kilograms (33,069 to 44,092 pounds), corresponding with the reboisement of 2,000 hectares. The cost on this account in 1862 was 38,515 francs. Later experience showed that there was no great economy in this course.

In 1861 there had been formed 273 nurseries with an area of 330 hectares, and a capacity for delivering 60,000,000 plants a year. In 1862 359 new nurseries were formed, covering 273 hectares and capable of furnishing 40,000,000 plants. In this year the expenses of old and new nurseries were 153,772 francs. The experience in nurseries tended to show great advantages to be derived from them above purchasing stock.

After the first three years, a reaction in public opinion began to be manifested, especially in pastoral communities. The system promised herbage after twenty years or so, but they must in the mean time live. The mixed commission for improving communal lands proved power-

less, and finally, as a concession, the law for *gazonnement* was passed in 1864, as already noticed.

Results of eight years of reboisement in France (Hectares).

Years.	Sanctioned reboisements.				Obligatory reboisements and gazonnements.			Total area of land covered with herbage and planted with trees.
	State lands.	Lands owned by communes and public bodies.	Lands belonging to private owners.	Total area.	Reboisements.	Gazonnements.	Total area.	
1861	1, 401. 95	2, 653. 70	583. 92	4, 639. 57	....	....	....	4, 639. 57
1862	1, 866. 03	5, 774. 58	1, 714. 15	9, 354. 76	2, 061. 87	....	2, 061. 87	11, 416. 63
1863	1, 750. 88	7, 073. 24	2, 157. 05	10, 981. 17	1, 853. 57	....	1, 853. 57	12, 834. 74
1864	1, 834. 70	6, 164. 32	1, 601. 01	9, 600. 03	2, 592. 29	....	2, 592. 29	12, 192. 92
1865	1, 170. 26	5, 198. 01	1, 392. 50	7, 760. 77	3, 107. 96	1, 050. 59	4, 158. 55	11, 919. 32
1866	986. 09	2, 909. 42	1, 739. 75	5, 635. 26	2, 811. 10	1, 144. 49	3, 955. 59	9, 590. 85
1867	611. 25	2, 783. 68	2, 007. 32	5, 402. 25	3, 263. 94	335. 48	3, 599. 42	9, 001. 67
1868	216. 50	2, 663. 20	2, 129. 63	5, 009. 33	2, 886. 97	212. 50	3, 099. 47	8, 108. 80
Totals	9, 837. 66	35, 220. 75	13, 325. 33	58, 383. 14	18, 577. 70	2, 743. 06	21, 320. 76	79, 703. 90

We are not able to present the results of 1869 and 1870, but when the above table was published it was estimated that the total result for the ten years would be about 95,000 hectares (234,650 acres), of which about 25,000 would be obligatory. It by no means, however, represents the work done. The surveys and plans prepared, and the numerous dams and other works constructed, should be taken into account in estimating the result.

It remains to be added that the law of 1860 having expired by its own limitation in 1870, the works of *reboisement* and *gazonnement*, previously sustained by a special grant, fell upon the ordinary budget, and the Franco-Prussian war, by drawing heavily upon the resources of the government, sadly reduced the means placed at the disposal of the administration for the continuance of the improvements.[1]

Still, no one has lost faith in this measure, and so far as it was allowed to go it has been a success. Repeated efforts have been made to secure a separate sum for this service as heretofore, but without success.

In the mean time, fearful inundations in the south of France have taken place, which forcibly illustrate the vast importance of these measures, as well to humanity as to the public interests generally. In 1872, in the valley of the Garonne, property to the value of 2,000,000 francs, and, in 1874, to the value of 2,600,000 francs, was destroyed by inundations. But a flood occurring June 21–23, 1875, presented effects more melancholy pehaps than any which have preceded it—a thousand lives being estimated as lost at Saint Cyprien alone, and a place of thirty thousand people "ceased to exist." The loss of life in all is estimated at three thousand, and one hundred thousand were made homeless in Southern France by these floods, which destroyed property too vast in amount for definite determination; by some placed at 300,000,000 francs, the government itself losing a third of this amount.

In September of the same year, in the same river, another inundation

[1] The grants for *reboisement* and *gazonnement* were 1,500,000 francs for 1871, 763,000 for 1872, 763,000 for 1873, 1,163,000 for 1874, 1,183,000 for 1875, and 1,683,000 for 1876. In each of the years 1873 and 1874 the sum of 200,000 was granted for buying lands on mountains.

occurred, which, though less fatal to human life, destroyed the vine harvest, valued at 8,000,000 francs. The losses in one department by by four floods, coming in three successive years, was 15,669,000 francs.[1]

THE PREVENTION OF TORRENTS AMONG THE ALPS.

A statement of the methods employed, and the difficulties to be overcome, in preventing the erosion of torrents, and in repairing the damages they may have done, will be of interest wherever there may be occasion to restrain or repair such injuries. These methods embrace the various dams and other barriers and devices constructed by engineers, as well as the planting done by foresters, and both classes of remedies must often be employed for securing these results.[2]

The disasters caused by inundations consist chiefly in the nature and quantity of the materials borne down by the flood, which they without doubt augment in volume and force. When these transported materials consists of mud the banks may not suffer, and the temporary disorder is always reparable, and sometimes this mud improves the soil, and increases its power for vegetable growth. But when these materials are stones and gravel, they carry ruin along their whole course.

The real damage from floods consists, therefore, in the degradation and transportation of gravel from the flanks of the mountains into the valleys, and the end in view is, therefore, to prevent these materials from moving. The means actually employed for this end are simple, but before stating them it will be proper, in order to make them understood, that we should indicate how this degradation takes place. It is in one of two ways, viz: By erosion at the foot of the mountains—this is the most dangerous; by atmospheric influences under the treading of sheep and goats—this is the more common manner. Being undermined at the foot, the mountains, composed of incoherent materials, loose their hold and slide; or being loosened by the frost, softened by the water, and trodden by flocks, the soil on the slope is washed down by the storms.

---

[1] Scientific inquiry since directed to the cause, shows the origin to have been in the naked valleys of the Pyrenees, and speecially that of the Aude, a torrent rising 2,130 meters above sea-level, and having most of its descent near the upper part of its course. It is about 141 miles long, and a considerable part once a fertile plain. The basin drained by this torrent has an area of 460,000 hectares, of which but 60,000 admits of the infiltration of water, the rest allowing a speedy delivery of the rain-fall, which, in the June flood of 1875, amounted to 691,000,000 cubic meters in fifty-two hours. The result of the inquiries made with reference to future prevention is, that besides strong dams for retaining the waters, the basin should be planted, and especially the waste-lands, with evergreen trees, which at all seasons intercept a considerable part of the rain. From three years' observation in this region, M. Rousseau found the rain-fall as follows:

	Millimeters.		Millimeters.
In winter, in the open air	179.3;	under woods	55.1
In spring, in the open air	162.7;	under woods	84.4
In summer, in the open air	302.3;	under woods	169.8
In autumn, in the open air	323.1;	under woods	162.1
	967.4		471.4

In the heavy rain-fall of June, 1875, the amount was 162.2 millimeters in the open grounds, and 108 under the shelter of trees; but this was a steady rain, and the leaves, once wet, only served to break the fall of rain, and the evaporation was little or none. Yet even this difference would have reduced the volume of the flood 35 per cent. The estimated cost of reboisement of 140,000 hectares, under peculiar difficulties, is 16,000,000 francs.—(Extract from *Atlas Météorologique de l'Observatoire de Paris*, in the *Revue des Eaux et Forêts*, July, 1877, p. 290.)

[2] This statement is translated from the *Revue des Eaux et Forêts*, 1872, p. 84.

Thus are formed immense excavations which discharge incalculable quantities of materials into the torrents which they border. It is estimated that twelve millions of cubic meters per annum have been passed at Perthius upon the Durance, near the Rhône.

Means employed to prevent this degradation.—The means practiced in the Alps to prevent this degradation consist in—

1. The prohibition of pasturage.
2. Banquettes, or general dams.
3. Partial dams.
4. Mule-paths.
5. Sustaining-walls of stone laid dry.
6. Drains.
7. The opening of parallel horizontal belts.
8. Coverings of wood, straw, &c.
9. Plantations of various kinds.
10. Sowing of forest seeds and sodding.

The prohibition of pasturage.—Pasturage, particularly that by sheep and goats, being the principal cause of these injuries, should be wholly forbidden within the district to be regenerated.

Banquettes, or general dams; partial dams.—In one or two years after taking the work in hand, (this time being necessary to ascertain the points where nature would be powerless of itself to consolidate the ground), they portion off the area to be artificially restored, into two or three great zones by horizontal banquettes, about 1.5 meters wide, with the view of catching all the waters, and of preventing them from acquiring a velocity. After these general dams, partial ones are also made. These dams are of variable dimensions, and of a certain form and construction; causing the deposit above them of large accumulations of sediment, which fill the bottoms of the ravines, brace up against the mass, consolidate the two opposite slopes, which thus mutually support one another, extend the water-level along the banks, and deaden by successive falls the velocity of the current. They are generally constructed as dry walls, are slightly curved upward, and are considerably higher at the ends so as to turn the water from the banks and force it to pass in the middle. But too much importance should not be given to the curve, which presents the great inconvenience of throwing the current to the sides, and causing whirlpools, which wear cavities and endanger the solidity. It is not even proven that these curves are indispensable, for in one of the strongest torrents of the Alps, several barriers very much curved downward resisted perfectly, which appears to indicate a feeble pressure. But it is prudent to arch them a little, both above and below, to prevent the ends from being undermined or turned, which often happens when the wall is straight on the other side.

According to the resistance they have to support, the floor of the barriers is fastened to sills of walnut, in concrete (this is best), or simply formed by large stones placed together in a bed of concrete that extends one or two meters, and is protected by a slope-wall, which they take pains to carry up to the level of the flow-line, as is done around the piles of bridges, with the view of preventing eddies. It is also prudent when there is reason to expect the passage of heavy substances, to clamp the stones forming the crown of the barrier and also the platform.

The height of these barriers ought to be sufficient to cause a filling up above them so as to obliterate the slope of erosion. Their thickness will vary between a third and a quarter of their height, with a slope of 0.15^m to 0.20^m to each meter in height, according to length of materials, with the lower side vertical and the slope above.

When stone cannot be had, they build these barriers of timbers and fascines, but these can never be of much size, nor are they very durable. They are only used in case of little injuries which vegetation will easily cover.

Mule-paths.—While building the partial dams they open within the limits of the work such paths as are necessary. These are about a meter wide and have an easy grade, so as to easily pass back and forth in supplying the works. These paths also are quite essential to the dams and facilitate the distribution of labor. Being destined at a future day for use as roads for removing the growth of wood, they ought, as much as possible, to be made with reference to this use.

Sustaining-walls.—In passing each ravine the mule-paths are sustained by dry stone walls or by the dams, according to the extent of the ravines.

Drains.—In the lateral ravines the simplest, cheapest, and most effectual method of arresting the process of degradation is by means of drainage. These drains are made by throwing into the bottom of the ravines whole trees, with the heads downward, together with fascines and branches, and then with powder throwing down the impending banks of earth, which, falling naturally into the lowest part, are crushed to pieces in falling. They thus obtain at once, along the whole length of the ravine, a large mass of loose earth, which raises the beds of the channel, sensibly reduces the steepness, and secures a deep, damp, and finely-pulverized soil, upon which, from the first year, they may establish a good vegetation.

When the bottom is solid, narrow, and very steep, it is necessary, in order to prevent sliding, to build redans in some places, and to make small dams, and for these purposes they employ conical gabions, with the open end above. These drains, even in the driest places, often collect water enough to form little springs through the summer.

Belts.—After the banks have become thus consolidated, the portions denuded and destined to be covered with vegetation are divided into horizontal belts, as also the zones affording pasturage, when superficial erosions are to be feared. These belts, the width of which is from 0.8 to 1.0 meter, are nearer together where the slope is steeper (being on the average 4 meters apart), but must not be too near each other, as they are then liable to slide. Being sufficiently sloping in toward the mountain, they arrest the water that falls, and force it to soak into the ground. They spade into the slope 0.4 to 0.5 meters deep, as much as possible the year before planting, so that the soil shall have time to harden by the action of the atmosphere, and to be comminuted by the frost.

Packing with clay and brush.—In very steep places the belts are sustained by the aid of a packing of clay and brush, or by dry stone walls. These packings and made with strong stakes, above which are fascines dipped in mud and packed with soil. These fascines by their slow decay serve to fertilize the soil, and to favor vegetation.

Coverings.—When the surface between the belts is easily degraded, or keeps its place badly, the parts most liable to this accident are covered with brush laid imbricating, rather thick, and top downward. They are also covered with all kinds of rubbish, in places most liable to erosion. These coverings, even without fastenings, retain the soil perfectly and protect it from the rains, by which they deaden their force. They retain the moisture of the soil, and hinder evaporation.

In the zones affording pasturage, the opening of belts, with sustaining-

walls, suffices to arrest the surface-wash; but it is better to sod them at once.

Planting and sowing.—After the dams, the drains, the opening of the belts and their covering, have, for the time being, fixed the soil, a vegetation should be established sufficient to hold it permanently. But what ought this vegetation to be, that shall consolidate the surface in such a way as to prepare it for all eventualities that can possibly be foreseen? Nature itself answers this important question.

In short, when we study in the Alps the formation of great erosions, we shall at once observe that the loosening of the soil on the steep slopes has immediately followed the destruction of the timber, and that it has only stopped when it has reached a limit where the ligneous vegetation has successfully resisted further injuries to the soil.

We find nowhere upon slopes given up to the pasturage of sheep and goats that the soil has been uniformly consolidated by herbaceous plants, while we everywhere meet with such grounds, which, after long periods of crumbling, have been fixed chiefly by the growth of trees. This is easily explained. The animals above mentioned pull up the herbs as fast as they appear, while ligneous vegetables may be browsed off, but not pulled out by the roots like herbs, and it is this difference that constitutes the superiority of tree-planting over sodding.

In the presence of these results, which strike every observer, no one can venture to assert that torrents can be restrained by sodding alone, or deny that reboisement is the most effectual means for fixing the soil in eroded places. Who does not furthermore know that woodlands, by retarding the melting of the snows, and by hindering the flow of water, compels it to sink into the soil, and thus contribute to the supply of springs, everywhere so useful?

An important question here arises which should be fixed before going further: as to what kinds and in what proportion the ravines ought to be planted, in order to fix the soil with certainty, and so as to meet the local wants in as satisfactory a manner as possible; for in an economical point of view the mountains are made for the population, and should be made to adjust their products to its wants, if we would seek to check emigration, the evil consequences of which need not be specified.

In gorges, trees of full growth, by reason of the difficulties in getting them out, have but a small value. Trees of large size cover the ground but imperfectly, and evidently protect it less than a young and dense coppice. Trees of feeble size are not a temptation to trespassers. Placed on the horizontal belts (more widely spaced apart where the slope is less steep) the young trees, besides benefiting these belts by the moisture that they produce, favor the growth of herbaceous plants, which after some years, may be gathered for use. This is a fact of some importance, since among almost all of the mountains the cattle are fed in winter with leaves and young shoots cut green about the beginning of September.

On the other hand, it is sufficient for stopping these superficial erosions if the lands are kept cultivated, and the intervals between them are kept sodded. All interests are, therefore, satisfied by either of these methods.

1. By planting the eroded portions in alternate belts with kinds of trees that shoot readily from their stumps, that have a rapid growth, and that may be easily worked at short periods of revolution. These conditions are offered in the acacias, ashes, elms, maples, and whitewoods,[1] and it is well to mix them according to locality; but we should

[1] Willows, alders, poplars, and lindens.

distrust the acacia, which grows vigorously during the first years, but is short lived.

2. By sodding the surface between the belts.

It has been said that bushes were not sufficient to protect the sod against erosions, and that large timber is better. This assertion is not confirmed by facts; in short, among the Alps, almost all the old forest regions are gullied by the water in some parts, while the thin and low coppices, which cover the greater part of the steep slopes, are very seldom injured; or, if they suffer some damage after cutting, they close them up very soon after by natural growth.

The choice of kinds being decided, we should point out the means employed to insure the success of the plantation. After a thorough preparation of the ground in advance, they open anew the belts to the bottom, and place the plants very thickly along them, covering the roots the tenth of a meter deep with soil, and then scatter over them a light coating of sheep-manure, using about a liter to the meter in length. They then water the plants, and as this element is most needed, they scatter along the row after planting, a little straw, which has the double use of forcing the rains to soak into the soil without running off and of preventing the soil from drying. The manure, which somewhat increases the cost, stimulates the growth very much during the first years and insures the success of the plantation.

Such are the means recently employed among the Alps to restrain the torrents and regulate their flow. But these labors are not limited in their result to the consolidating of the soil and the prevention of torrents. They bear an intimate relation to irrigation, which requires not only that the supplies of water shall be reliable, but also that it shall be clear; for, if not, the channels would be filled with mud at every shower. The dams, by checking the velocity of the waters, purify them of these sediments with which they are charged, and upon each dam we may with certainty depend for supply. These works are, therefore, the indispensable complement and dependence of systems of irrigation in mountainous regions liable to erosion.

But it will not suffice to close the breaches made, if we do not prevent the formation of others. The immoderate use of pasturage being the principal cause of these damages, it is of first importance that this should be regulated. This is a necessity, and an imperative duty on the part of communal proprietors. In fact, if the communes are proprietors, they are only holding in usufruct for the generations that are to succeed them, as the good father of a family seeks always to improve, and not to destroy. In like manner, it belongs to the prefectoral authority, their guardians, to regulate their powers, and abuses ought, therefore, to be opposed with energy.

Furthermore, the present generation cannot fail to find a benefit in this regulation, since by its means they will be saved from losing all hope of pasturage, as now threatened everywhere, every leaf to the root being eaten off by their starving flocks,—and will be assured of increasing very sensibly the means of supplying food to their animals, which can be supplied with less fatigue and in greater abundance.

Results obtained, influence upon the population.—The process of restoration above described, and actually in operation throughout the Alpine regions, has everywhere had an immediate and remarkable result upon the population. There are none who now doubt the complete success of the enterprise. It is worthy of remark, that the prohibition of pasturage has led to the suppression of the flocks which had been bought in the way of commerce, in the spring-season, by a few individuals, to

devour in the summer months not only their own pasturage, but that of the communes, so that the inhabitants in many communes now say that they have been freed from an insupportable tyranny that had been exercised at their expense by speculators.

RECENT LEGISLATION IN PRUSSIA IN REFERENCE TO THE MAINTENANCE OR PLANTING OF TIMBER FOR PROTECTION, AND TO THE FORMATION OF FOREST-ASSOCIATIONS.

The Prussian Government, impressed with the serious dangers that may result from the destruction of forests, under circumstances where their presence was necessary for protection, more especially upon mountains, upon exposed sea-shores, and upon light, sandy soils liable to movement by the winds, has been seeking for many years to find a remedy, by legislative enactment, that should operate with equal justice upon both the owners of the dangerous property, and upon that which might be endangered. There were also many instances in which small adjacent pieces of woodland, belonging to different owners, should be managed under one direction, with the view of securing the greatest benefit to those concerned. These two objects are sought to be secured by a law passed July 6, 1875.

Before giving the text of this statute, it may be proper to present the motives that led to its passage, and a short account of the differences of the regulations among several of the Prussian states, with reference to the care of forests. The complaints that were made prove that these measures were inadequate to secure the maintenance or planting of forests where their presence was necessary for protection, and where the land belonged to individuals or communes.

From 1830 to 1848 a law was draughted for the adoption of measures to prevent sand-filling, and the fixing of sands in inland places, and directions were issued for the supervision of private forests in these cases, which were designed to apply to the whole country. The events of 1848, however, prevented the government from arriving at any definite result at that time. Various local regulations, suited to particular districts, had, from time to time, been established, yet without satisfactory result;[1] and the experience from all these trials only tended to show that the objects desired could only be secured by general law. In 1868 the question was again raised, and a bill was submitted before the House of Deputies for the compulsory formation of forest associations; but the near approach of the end of the session caused it to be sent to the Commissioner of Agriculture. The Chamber of Deputies, during the discussion of the budget of the forest-service in 1873 expressed a desire to have the Government submit a project to secure the desired ends, and a plan which had been prepared with much care in 1868 was submitted January 20, 1875. Although approved by both Houses, the principal discussions upon its provisions was had only in the House of Lords. It was finally passed on the 6th of July, 1875, with some amendments. It may be proper, for the purpose of explanation of the general points of the new law, to present a brief notice of existing legislation in regard to the right of the state to the supervision of the forests.

The recent law recognizes the right of the Government to exercise its inspection and management in the communal forests of the whole em-

[1] For the district of Olpe, May 27, 1821; for that of Siegen, December 6, 1834; and for the Bailwicks of Freusburg and Friedenwald, in the district of Altenkirchen, November 6, 1836. After the first attempt at general legislation failed a special law was applied June 1, 1854, to the district of Wittgenstein.

pire, but in certain provinces under principles that are essentially different. These differences may be stated under four principal heads:

1. In the provinces of Prussia, Pomerania and Posen, Mark and Silesia the State supervision is restricted to a *consent* to sales or changes in the enjoyment of the forest-products of cities, and to clearings and extraordinary cuttings in the communes. In Hanover, its inspection is limited to watching over the maintenance of capacity for supply. With these exceptions, the communes administer their forests as they see proper.

2. In the provinces of Saxony, Westphalia, and the Rhine the communes look after their own forests, but they are bound to submit, for the approval of the District Government, all projects of sale, clearing, or extraordinary cuttings, conforming themselves for technical management, to the principles sanctioned by the Department. They are to employ agents properly instructed and examined by the Government. The district authorities may cause local examination to be made as to technical management, according to annual plans of production and working. The right of state supervision in the formerly Bavarian portions of the country, and substantially in the earldoms of Hoga and Diepholz, in Hanover, is regulated in the same manner.

3. In the former principalities of Calenberg, Gottingen, and Grubenhagen, in the province of Hanover, as well as in the old duchy of Nassau, the technical administration of communal forests rests with the State forest officers ("*Oberforst-beamten*" and "*Oberförster*"). Under the direction of the District Government, these officers are required to prepare plans for the general administration, for the annual cuttings, and for management. They are to see to the execution of these plans, and to cause the expenses to be properly placed. They are to give direction regarding mast, leaves, grass, and pasturage. The communes are required to pay a fixed sum per morgen for these expenses. They have no voice in the appointment of these agents. Besides this, the communes of both sections are required to employ and pay special officers for the protection of the forests, the appointment of whom in Nassau is with the supervising authority, and in the Hanoverian part of the country with the communes under the direction of the business administration. In both sections, the technical administration is limited to a hearing in regard to their wishes respecting the settlement of the general and annual plans of administration. The communes are required to furnish the pecuniary means necessary for the execution of the annual plans for cutting and management. The disposition of the timber when cut is left to themselves.

4. Finally, in the former electorate of Hesse, the working of the communal forests is vested in the State authorities, in the same manner as those belonging to the Crown. The "*Staatsrevierförster*" (Oberförster) fixes the plans for working and annual cuttings, which the *Forst-inspectors* examine, and the *Oberforst collegium*, as the judge of the inspection, causes them to be executed. The *Revierförster* is required to execute these plans, and to deliver to the local authorities all of the forest products and revenues. In the disposition of these products, the latter are not restricted. The *Oberforst-collegium* appoints the forest servants, as needed for the protection of the forests, and reserves disciplinary power over them. The management of communal forests is therefore wholly under State supervision, except as in a very limited way, united with the local authorities.

In the former grand duchy of Hesse and in Hesse-Homburg the main points of the law are similar, except that the presidents of communes

have the right of offering their observations and objections against proposed legislation and management.[1]

In regard to the administration of forests belonging to institutions (churches, schools, &c.) in the five eastern provinces, a State supervision is not particularly prescribed by law. As for the remainder, they are not restricted in the management of their forests.[2] In the former duchy of Nassau, the administration of forests for all uses, is left with the owners. The State authorities are empowered to take measures to prevent the entire devastation of woodlands. The proprietors are required to furnish the *Revierförster* with statistics of the annual cuttings and cultivation, but are not bound to accept and carry out any of his directions beyond the restriction of devastating practices.[3]

Private forests are, like the preceding, subject to a variable legislation in the different provinces. In the old Bavarian provinces, individuals have not the right of clearing or of entirely cutting off the forests located on the slopes or summits of mountains, or on pebbly ground, or in places where their presence is necessary to retain the soil, or to maintain the supply of springs and rivers. They must also replant parts destroyed by fire. Fines are imposed for violation of these rules, and the work of reboisement is executed at their expense. Beyond this the proprietary right is not subject to restrictions. In the old duchy of Nassau, the administration of private forests is left with the owners, but the State agents may interpose to prevent clearing and devastation. Owners are obliged to make annual reports of their cuttings, and upon the management of their woodlands, without, however, being restrained, provided that their working is not of the nature of devastation, when they must accept the modifications proposed by the agents.

In the old electorate of Hesse, the forest authorities may oppose the devastation of private forests, and compel their owners to replant wasted portions.

In Hesse-Homburg, individuals cannot destroy their forests, and for all properties having an area of over 20 arpents, plans of cultivation and of working must be submitted to the authority charged with inspection.

In the provinces of Schleswig-Holstein, the owners of forests are subjected by the State to certain rights of usage as to fire-wood, in favor of villages, and must work according to rules of management, and may not clear without the permission of Government.

In the provinces of the Rhine, all clearing is forbidden without previous license from the Government, and the forestal authorities have the right to forbid all working contrary to the principles of forest economy.

In the other provinces, the State does not enjoy the right of inspection that is exercised over private forests in the provinces above designated; every owner has the right to enjoy and to dispose of his forests as he chooses, so far as the rights of the public are not affected.

Under the operation of actual law therefore, in the different provinces in the empire, there exists a difference almost fundamental between the administration of communal forests and those belonging to individuals; and while the former are everywhere subject in a greater or less degree to the surveillance of the State, the latter are for the most part completely free.

---

[1] Electorate of Hesse, edict of organization, June 29, 1821, and regulations of March 5, 1840. Law of Hesse-Homburg for forest organization, February 5, 1835. Ordinances of grand duchy of Hesse, April 1, 1822, December 29, 1823, and June 23, 1831.

[2] Bavarian forest law of March 28, 1852.

[3] Nassau, edict of November 9, 1876.

Prussian law of July 6, 1875, *concerning forests for protection, and concerning Forest Companies.*

I. GENERAL PRINCIPLES.

SEC. 1. The management and working of forests are not subject to the restrictions of the general police that regulate the present law.

Particular regulations existing concerning the working surveillance and administration of the State forests, and those belonging to communes, societies, and establishments, as also the forests of Schleswig-Holstein, designated under the name of *Bondenholzungen*, will remain in force.

II. PROTECTIVE MEASURES FOR THE PREVENTION OF DANGER.

SEC. 2. In cases when—

(*a*) In consequence of the sandy nature of the soil the adjacent lands of public works, or water-courses, either natural or artificial, might be injured by moving sands;

(*b*) In consequence of the abrasion of the soil, or the formation of torrents upon denuded highlands, or the summits and flanks of mountains, the properties of those below, roads or dwellings, are threatened with destruction, or with being covered with avalanches of earth or stones, or of even being carried away, when such properties public works, or structures are located on the mountains;

(*c*) In consequence of clearing the forests situated upon the banks of canals, or of natural water-courses, the neighboring lands may be damaged by the waters, and when constructions or public works placed under the protection of these forests are in danger from the breaking up of ice;

(*d*) In consequence of the clearing of a forest there is reason to fear a diminution of ponds and streams—or;

(*e*) In consequence of the clearing of a forest, in a denuded region, or near the sea, the cultivations and villages adjacent may have occasion to dread the disastrous effects of the winds—

To avert the danger in such cases, the mode of working, as well as the execution of certain forest cultivation, or analogous works of protection, shall be regulated by the rules laid down in the propositions following:

SEC. 3. Proposition of regulation in conformity with paragraph 2 may be made—

(*a*) By any one whose interests are menaced;

(*b*) By the communes, districts, or by those concerned in common interests, in the various cases coming under paragraph 2 that may present themselves in their several capacities;

(*c*) By the police authorities of the country.

SEC. 4. The proprietors, tenants, and farmers of premises that may as above endanger, are required to employ in their working, all the precautions necessary for the application of paragraph 2 of the present law, and to execute the forest cultures and the works of protection that may be ordered. They will, however, be allowed an indemnity for the damages which these restrictions upon enjoyment may occasion.

The proprietors have a right to ask to establish and maintain at their charge, the works of protection ordered, but they must remain subject to the inspection regulated by paragraph 20.

SEC. 5. The expense of establishment and maintenance of works for protection, as well as of indemnities, shall be regulated upon the following principles:

Those who have made the request, shall be responsible for the indemnities, and for furnishing the sums necessary for the establishment and maintenance of the works of protection, and of the forest-cultures in paragraph 2.

However, in cases *a*, *b*, and *c* of the said paragraph, the owners of the premises endangered shall contribute to these expenses in a certain proportion, which shall not exceed the value of the damages to be prevented.

The owners of the dangerous premises shall also, in all cases included in paragraph 2, contribute to these expenses of works of protection in a proportion that shall not exceed the difference in amount of value they will derive in consequence of such regulations.

SEC. 6. Every proposition, in so far as it does not bring the public interests into question, may be withdrawn prior to the determination of its regulation by the Tribunal of Forest Protection; but in the cases *a*, *b*, and *c* of paragraph 2, after the publication of the rules of the commission, it shall not be withdrawn until its author shall have paid his quota of the indemnities, and of the expenses of construction of the works of protection.

SEC. 7. The committee of the circle and in the provinces of the principality of Hohenzollern, the committee of bailage shall be judges in this question, and shall fix the rules to be observed in each particular case, as also the indemnities and the charges (section 5). These committees shall be known under the name of the Tribunal of Forest Protection.

The procedures before this tribunal, appeals from its decisions, and the procedures in cases of appeal, shall be in conformity with the rules of common justice. Proceedings before this tribunal shall, however, be subject to the following rules:

SEC. 8. Propositions for regulation, in conformity with paragraph 2, shall be submitted in writing to the competent tribunal.

The dangerous premises, as well as those menaced, and the kind of danger shall be therein exactly indicated, and a project of measures to be taken for proteetion, shall be also annexed.

The competence of the tribunal shall be determined by the location of the dangerous lands. Whenever the proposition emanates from the district itself, or is directed against it, the judicial administration shall decide as to what is the competent tribunal.

SEC. 9. The tribunal shall charge one of its members, or if need be, an expert, as a commissioner for examining the question in its general aspect, and upon the spot, and to make a report containing all necessary evidence.

SEC. 10. The tribunal may, upon the proposition of this commission, or of the parties interested, before giving judgment, decide whether there is danger within the meaning of paragraph 2, and may suspend all discussions until this point is settled.

The commissioner shall, before deciding the question, prepare a written proposition, which shall be open for the inspection of those interested, in accordance with section 13.

SEC. 11. The examination by the commissioner in the preparation of his plan of regulation, shall bear upon the following points:

1. The pointing out of the dangerous premises and of the premises endangered.

2. The restrictions to be imposed in the working of the dangerous premises.

3. The establishment, maintenance, and supervision of the forest cul-

tures necessary, and the analogous works of protection that may be required.

4. The nature of the indemnity:—By whom should it be paid? In what proportions? What should be its amounts, and within what time ought this as well as the expenses of the works of protection to be provided?

SEC. 12. To the project of regulation there shall be annexed a report wherein shall be fixed the advice prepared, and wherein shall be discussed the questions that may be raised.

SEC. 13. The commissioner shall, within four weeks, deposit with the president of the commune of the territory wherein the lands in question are located, his advice and the rules he recommends, in order that the proprietors, tenants, and farmers of the dangerous premises, as well as those whose interests are endangered, may take knowledge, and he shall give notice to those interested of his having done this. If the proposition emanates from a commercial association, or from the police authority of the country, the advice and rules for regulation shall be notified to them. At the same time the commissioner shall convene all those interested for an oral discussion upon the objections raised against the project of regulation, giving notice that all objections after this conference will be rejected by the tribunal for forest protection.

In this oral discussion, the commissioner will examine the objections and the counter-propositions, and will determine the points upon which the members cannot agree.

SEC. 14. The tribunal shall judge of all complaints formally presented concerning the conduct of affairs by the commissioners.

SEC. 15. When there are no objections, and when the public interests are not affected, the tribunal may, without further information, adopt and legalize the regulations. Notice of the decision shall be given the parties interested, and in these notices there shall be allowed ten full days to allow time for their request for appeal and for oral discussion. If no objection is made, the decision of the tribunal shall be of full effect from the day it is declared.

SEC. 16. In case of oral discussion before the tribunal, the parties interested in the danger, the proprietors, tenants, or lessees of the dangerous property, and those entitled to servitudes and the author of the proposition (sections 4, 5, and No. 4 of section 11) shall be convened by special letters; all other persons who may have any interest whatever in the question shall be notified by a note inserted in the official bulletin of the circle or district, with advertisement published one week, that in case of non-appearance the matter will be decided in accordance with the deliberations had.

The ordinary tribunals shall be competent judges of such questions as may be raised concerning the existence or extent of private rights.

SEC. 17. The contribution to indemnities and to the expenses of establishment of works of protection (section 5) imposed by regulation upon proprietors or lessees of the dangerous or endangered property shall be borne by these lands in manner similar to the common public charges.

This contribution shall be laid upon each parcel proportionally according to an assessment. The arrears due by the farmers and other lessees of the products of the land in question may be recovered in manner officially provided, reserving to the latter due recourse to the proprietors. The restrictions imposed upon the owners of dangerous lands and of lands endangered, shall be inserted in the cadastral register under the head of objects supervised by the authorities. This insertion shall be made on the order of the president of the tribunal.

SEC. 18. The transactions and debates pending the course of proceedings, as well as the insertion in the cadastre, and the reports furnished by the tribunals or other authorities, shall be exempt from stamp duties and gratuities, and the actual expenses only shall be authorized.

The commissioners, when not members of the Tribunal of Forest Protection, and the experts, when called, in whatever concerns their expenses and the cost of travel and sojourn, shall be paid in conformity with the regulation of April 25, 1836, and the subsequent decisions that may have been had upon this subject.

No member of the tribunal, when appointed a commissioner, shall claim repayment for traveling-expenses in fixing the regulation of cost.

SEC. 19. The cost of necessary proceedings shall be defrayed by the common treasury of the circle; but, if the motion emanates from the police authority of the country, it should be paid by the latter. It shall be supported by the author of the propositions alone whenever they may be rejected or withdrawn; otherwise the regulation of costs shall be fixed in conformity with the rules laid down in paragraphs 4 and 5 of the present law, relating to the payment of indemnities and expenses occasioned by the aforesaid constructions.

SEC. 20. The execution of regulations, in particular the apportionment and collection of the contributions fixed upon for indemnities and expenses of construction of works of protection, the payment of indemnities, and of supervision of execution, the payment for works ordered, and the observation of prescriptions of regulation devolve upon the president of the Tribunal of Forest Protection.

Every reclamation against an order of the president, contrary to regulations, should be filed within ten days after the notification of the order for judgment by the tribunal.

SEC. 21. In case of urgency, the president of the tribunal may, in the public interest, and before any legal decision, take such measures as may be necessary to stop any enterprise which may augment the danger, by modifying the working of the land. These orders should be taken in the way of legal restraint, conformably to paragraphs 79 and 81 of the royal ordinance of December 18, 1872.

Every reclamation against the orders or penalties imposed for contraventions may be filed with the tribunal of the administration within ten days after notification.

SEC. 22. Every subsequent modification of regulations should be proposed by the parties interested, and will be under the same instructions as in the case of a primary regulation.

III. CONCERNING FOREST COMPANIES.

SEC. 23. In cases where lands in forests, adjoining or surrounded by others, cannot be conveniently worked except by a common association of the proprietors, then, upon the proposition—

(*a*) Of each individual proprietor;

(*b*) Of the commune of the circle or bailage, or of a communal association of the same kind, upon the territory of which the lands are located; or

(*c*) Of the authority of the police of the country;

The proprietors in question may unite to form a forest company, for the purpose—

1. Of regulating and obtaining a common protection, and of taking the measures necessary to secure a convenient working of the lands of the company;

2. Of administering in common, and according to a uniform plan of working, under the rules of forestal economy, the forests of the company.

SEC. 24. A company is only permitted—

(*a*) In the case mentioned in paragraph 23, No. 1, whenever the majority of the interests, ascertained by the revenues of the land, as indicated by the cadaster, shall have subscribed to the proposition.

(*b*) In the case mentioned in paragraph 23, No. 2, whenever at least a third of those interested shall have adopted the proposition, the revenue of their lands exceeding at least one-half of the cadastral revenue of all the lands to be put in common.

SEC. 25. The legal relations of the company and of its members shall be regulated by statutes. The principle of this regulation is as follows: No change shall be brought to bear in the manner of enjoyment or of particular property of those interested.

The statutes shall be adopted by the majority, as ascertained by paragraph 24.

SEC. 26. The statutes should contain—

1. The name, locality, and object of the company.

2. An exact description of each particular piece of land, and of the extent of the company's property.

3. For companies formed for the object defined in paragraph 23, No. 2, the mode of administration, the plan of working, and the proceedings to be had in introducing modifications, as well as the administrative rules to be observed till the establishment of a plan of working.

4. The restrictions and obligations imposed upon the associates.

5. The relations between the associates and those entitled to servitudes.

6. The participation of each one in the benefits and burdens (section 27) and in voting.

7. The formalities by which the partition lists should be published, and the time within which reclamations should be examined.

8. The internal organization of the company and their duties.

Every company shall have a president, who in all cases, and in the acts and processes in which the law requires some one to answer, shall be charged with representing it, according to formalities regulated by statute.

SEC. 27. The participation of each associate in the common organization shall be fixed in the statutes for the whole period of duration of the company, according to the following principles, in the absence of other verbal conventions agreed upon by those interested:

(*a*) In the case stated in paragraph 23, No. 1, each associate shall himself administer his land and support its expenses; but the cost of the common organization shall be divided among all the associates in proportion to the net revenue of each from his land, as shown by the cadaster.

(*b*) In the case stated in paragraph 23, No. 2, the benefits, charges, and expenses of the common working of the forests of the company shall be divided among all the associates in proportion to the capital value of the funds and the area of his domain.

In the latter case it is always permitted to a proprietor to clear and sell to his own profit, before entering the company, the area ready for working; but in this case he must defray alone the first expense of reboisement. In like manner, each associate proprietor of a piece of land not wooded shall be held to sow or plant at his own expense. In both

cases they will be required to render an account to their associates in the establishment of their quota of the first expenses of cultivation.

SEC. 28. Unless agreed upon to the contrary, the proportion of votes allowed to each associate shall be regulated according to their participation in the charges and benefits. The share of the smallest interest shall be taken for unity, and there shall be no account made of the fractions of unity. Every associate shall have the right to give at least one vote, and no one shall be allowed to represent more than two-fifths of all the votes.

SEC. 29. The obligation to contribute to the company's charges rests upon the land put in common, and shall assimilate to the common public charges.

The charges shall be divided proportionally upon each parcel of land, according to a schedule of parcels.

The arrears due by the farmers or tenants of the lands in question may be recovered in the manner of legal collection, saving recourse of the latter against proprietors.

SEC. 30. If the lands of the society are burdened with servitudes, their proprietors should bring all the restrictions that may appeal to the interests of the company in allowing indemnities to those interested.

SEC. 31. The creation of a forest company will be authorized by the committee of the circle, and in the principality of Hohenzollern by the committee of bailage.

These two committees, therefore, take the designation of "the Tribunal of Forest Protection."

The application should be made in writing to the tribunal of the district within the territory of which the lands to be put into common interest are located, either wholly or the greater part. When it emanates from the circle itself (or bailage in the principality of Hohenzollern), the judicial administration will designate the tribunal competent to give authority. The proposition should, for each piece of land, indicate the location, state the specifications of the cadaster, and give a complete report of each.

SEC. 32. The tribunal shall, in conformity with paragraph 9 of the present law, examine the application upon the spot, through a commissioner, who shall be instructed to convene all those who are interested for a discussion of the proposition. This meeting shall be called by writing, with the advertisement that the absentees will be considered as accepting the decisions of the members present.

SEC. 33. If the formation of the company is not concluded (sections 23, 24, 32), the commissioner stops further discussion, and the tribunal in this case rejects the application by a recorded vote.

SEC. 34. In the opposite case, the commissioner should conform to the prescriptions of the present law, and, after particular consideration, he should, with the concurrence of those interested, or with a committee appointed by them for this purpose, elaborate a plan of statutes, and regulate the restrictions relating to servitudes, unless the laws in force may enable to secure their extinction, and to secure the indemnities that should be allowed to those having an interest.

This plan, and these regulations, shall be according to the formalities indicated in paragraph 13, and it shall be made known and submitted for the approbation of those having an interest.

SEC. 35. In the mean time the commissioner shall convene for oral discussion, those having an interest and those having rights of use, notifying them that absence on their part will be considered as a token of consent to the project.

In this oral discussion the commissioner shall examine the objections raised against the project of statutes, or against the regulation of restrictions of servitudes, and of the corresponding indemnities, and shall fix the points upon which an agreement cannot be gained.

He shall submit the discussion to the tribunal, with his advice upon questions of necessity.

SEC. 36. If the project of statutes is not agreed upon in the oral discussion by the majority vote specified in article 25, the tribunal shall declare by resolution, the rejection of the proposals for establishing a forest company.

SEC. 37. In the opposite case, the tribunal shall establish, by a definitive decision, that there exists a necessity, in conformity with paragraph 23, of uniting the proprietors having interest in a forest company, in case the statutes have been accepted by the vote legally necessary—if they conform to the principles of law, and if they injure no public interests. If no objections are raised upon these various questions, the tribunal shall declare the constitution of the company as adopted, according to its statutes. At the same time the tribunal shall take cognizance of the observations that have been made, the rules of restriction upon servitudes, and the fixing of the corresponding indemnities.

SEC. 38. If the formation of a forest company is decreed, and the decisions precedent, in paragraph 37, are concluded, the tribunal shall ratify the statutes. The company shall be constituted according to these statutes, which shall possess the force of law.

SEC. 39. The restrictions and charges imposed upon the owners of the lands belonging to the company should be recorded in the cadastre, under the head of articles to be supervised by law. This record shall be made upon the order of the president of the tribunal.

SEC. 40. The rules of paragraph 14 are applicable to the procedure followed before the commissioner, and those of paragraphs 18 and 19 as regards the payment of expenses. These expenses, if they have not been placed by the tribunal to the charge of a part, shall be borne by the associates, in the proportions indicated by paragraph 27 of the present law, and inscribed in the statutes in the chapter of charges.

SEC. 41. Procedures before the Tribunal of Forest Protection, appeals from its decisions, and procedures in cases of appeal, shall be in conformity with the rules established by law for the administrative tribunals.

SEC. 42. The company may, in its own name, acquire the rights and make contracts to do upon estates every act proper and consistent with justice, as plaintiff or defendant. Each company shall have legal resort to the tribunal where it has its seat.

SEC. 43. The company is responsible for its engagements. Any debts which it cannot pay shall be borne by all the associates, in the proportion determined by the statutes.

SEC. 44. Every company thus formed is placed under the supervision of the State. Each tribunal of forest protection shall exercise this supervision in conformity with the statutes of the company, and to the same extent that the law confers upon them the supervision of communes.

In cases of urgency, the president of the tribunal may, in the name of the latter, take any action that may be necessary. All protests against these measures shall be judged by the administrative tribunal.

SEC. 45. If in course of time it becomes necessary to modify the statutes, the same procedures shall be followed as were adopted in beginning for their establishment.

SEC. 46. In case of the dissolution of a company, established on the basis of paragraph 23, No. 2, each associate shall recover possession of his land, for management to his own profit. Beyond this, unless otherwise stipulated in the statutes, the materials existing in the company's forest shall be divided among all the associates, in proportion to capital-value of material of each at the time when the company was formed.

If the value of material at that time is less than that at first, the difference in deficiency shall be made up by those to whom the forest has gained a greater value.

IV. PARTITION OF COMMUNAL FORESTS.

SEC. 47. Every application for partition, authorized by law, in the case of a forest belonging to a commune, or to a company, which may by this dissolution be compromised in the economy of its working, must be approved by a majority of those interested in the partition.

V. TEMPORARY REGULATIONS.

SEC. 48. In provinces of the monarchy where there are at present no tribunals of administration, the duties conferred upon them by the present law shall, until their establishment, be exercised in the first resort by special tribunals, to be known as Tribunals of Forest Protection, according to the wants of each circle, and after the prescriptions of the following paragraph; and in the second resort, by the provincial deputations. (Sections 40 and 41, laws of March 8, 1871.)

SEC. 49. The Tribunal of Forest Protection shall be composed of the chief of the circle as president, and of six members nominated by the assembly of the circle, by the absolute majority of votes. With the exception of the military on duty, any German citizen is eligible—

(*a.*) Who has his domicile in the circle.

(*b.*) Who is in enjoyment of his civil rights.

It is furthermore required that he shall have completed his twenty-first year, and that the care of his property has not been taken from him by a judicial council. Clergymen, servants of churches, and teachers of elementary schools cannot be members of this tribunal. Officials in the judicial order (among whom those technically members of Tribunals of Commerce and Industry should not be reckoned), are ineligible to this place, unless by consent of a competent ministry.

Members are elected for six years. Every two years the assembly will renew them by drawing out a third by lot, but the members so drawn can be re-elected. They are to take the oath at the hand of the president, and cannot be removed except by a decision of the deputation for home matters. They will receive from the communal treasury a payment for their services. The diet of the circle decides the amount.

SEC. 50. The tribunal may deliberate when three persons, including the president, are present. Their decisions are fixed by a majority.

When the object of discussion affects the interest of any member of the tribunal, or that of one of his relatives, or of one allied in direct or collateral line within the third degree, he cannot take part in the deliberations. When a tribunal finds itself thus incapacitated for business, the provincial deputation may bring the affairs before the tribunal of a neighboring district.

SEC. 51. Until the establishment of a tribunal in each circle, all applications (sections 3 and 23) should be addressed to the chief of the circle, who will be charged with organizing at once a tribunal of forest protection.

In urgent cases, the chief of the circle shall take, conformably with section 23, all the measures that may be necessary.

SEC. 52. The requirements of paragraph 49, 50 and 51 are equally applicable to the circles of free cities; only that the chief of the circle shall in that case be replaced by the burgomaster, and the assembly of the circle by that of the deputies of the city.

VI. PENAL REGULATIONS.

SEC. 53. Every owner, tenant, or farmer who shall cut down wood contrary to the prohibitions of paragraph 20, shall be liable to a fine of double the value of the wood cut.

Every violation of an article of regulation required or forbidden, in manner of special working, shall be punished by a fine not exceeding 100 marcs (about $25).

SEC. 54. The minister of agriculture is charged with the execution of the present law.

SWITZERLAND.

Recent Federal law for Reboisement.

In former times, no regard whatever was paid to the maintenance of forests, and the few regulations that were adopted, referred rather to the mode of using their products and to commercial affairs, than to improvement. But to this general statement an exception should be made since ancient times, with respect to cases in which woods in certain places served to protect houses, roads, or valuable property against avalanches. During the first thirty years of the present century, the attention of intelligent persons began to be turned toward measures for the preservation of forests; but the extraordinary devastation from storms and other agencies, in 1835, gave rise to the most active forestal legislation. Attentive observers saw that the destructive force of the waters was greatly increased by the inconsiderate clearing of entire slopes, and that the rapid discharge of the waters occasioned extensive erosions. The reports made by experts appointed by the Swiss Society of Public Utility for the inspection of the ravaged districts, and for inquiry into the causes, entirely confirmed this observation, and strongly attracted public attention to the necessity of adopting measures for the protection of the forests. The increased prices of wood, resulting from the development of new industries, gave further importance to the forests, and created a demand which often brought this material from places distant from those where it was used.

From this period legislation became frequent, and, in most of the cantons laws for protection and management were enacted, but not upon a uniform plan, and often quite short of the real wants of the occasion. In Schwytz and Zug, no regulations were made. In Appenzall, Glaris, Uri, Unterwald, and Basle-Campagne, only a few rules were established, but without a personal forestry service. In the other cantons the regulations were more or less complete, but so different that a concise account of their provisions could not be given. One of the best of these systems was that enacted in the canton of Vaud. In fact, it had but one serious fault, which was in the sections relating to the gathering of leaves and litter for bedding and fertilizing. Among the better class of forest regulations may also be mentioned those established in the cantons of St. Gall, Grisons, Tessin, Lucerne, Berne, Freyburg, Valais, and Soleure.

Hitherto these forestal regulations had been entirely under the authority of the separate cantons; but experience showed every year, more and more, the absolute necessity of certain general regulations, especially in matters relating to the water-courses and forests, for protection. The Swiss Federal Government, on the 8th of May, 1858, decided to cause an inspection to be made of the forests upon the high mountains, from which the principal water-courses of the country flow. The inquiry was to embrace every fact bearing upon forestal economy, the regulation of the waters, and geological conditions.[1] From a report made in 1861, we derive the following facts:

Total area of the country, 8,183,599 acres.

Wooded area, general average, 18.8 per cent.[2]

(The least proportion is in the canton of Uri, where it is but 6 per cent.; the greatest is in Schaffonsen, where it is 36.1 per cent.)

Forests owned by the State, and by communes and individuals unknown, in 12 cantons. But in most of the remainder, the larger part belongs to communes; although in Geneva, Thurgovia, and Zurich, the larger part belongs to private owners.

Annual production as actually worked, 89,354,300 cubic feet.

Annual normal production, 118,374,000 cubic feet.

Number of families (census of December, 1860) 537,728, averaging 4.8 persons in each.

Consumption, 224 cubic feet per family, or 118,167,040 cubic feet per annum.

Excess of consumption over production 31,884,130 in 21 cantons, and 3,071,390 less in 4 cantons; excess of consumption for the whole country, 28,812,740 cubic feet.

Exportation, 12,431,000 cubic feet; importation, 6,816,000 cubic feet; excess of exportation over importation, 5,615,000 cubic feet.

Difference between production and consumption, 34,427,740.

From these data it appeared, that the forests supplied only 76 per cent. of the material needed for consumption, or, if other combustibles were included, there would still be a deficiency of 4 per cent. The commerce in woods showing a balance against the country continued to be carried on at the expense of the forests, and from year to year tended to constantly increase this difference. The metallurgical and other industries were also continually tending to create a greater demand, and already in some cantons this inconvenience was gravely felt.

Concerning the influence of woodlands upon the water-courses, and the maintenance of fertility in the soil, the report above noticed remarks as follows:

1. The irregular condition of the water-courses which swell, discharge rapidly, and overflow in heavy rains, is due to the clearing off of mountains, especially in steep slopes. The rains run off such denuded slopes as they would from a roof, and discharge themselves quickly into the nearest streams. The rain falling upon a forest is on the contrary divided, a part remaining on the leaves, is evaporated, or comes

---

[1] The hydraulic part of this investigation was assigned to M. Hartmann, an engineer of Basle, and M. Culmann, of Zurich; the geological, to M. Escher de la Linth, and the forestal to Prof. E. Landoldt, now connected with the Polytechnic Institution at Zurich. The latter, in June, 1871, made a report to the Federal Government, from which many of the facts here presented were derived. (*Rapport au Conseil Fédéral sur les Forêts des Hautes Montagnes de la Suisse, inspectées daus les années* 1858, 1859, and 1860. Lausanne, 1862, p. 366.) The author of this report was accompanied in each canton by a forester officially employed under cantonal authority, except in those that had no such officers, in which M. Wietlisbach, inspector of forests at Aarau, performed this service.

[2] In adjoining countries this proportion was stated to be as follows: Austria, 39 per cent.; Southern Germany, 25 to 33; Prussia, 29; and France, 16. But deducting portions absolutely sterile, the forests of Switzerland occupied about 22 per cent. of land capable of improvement.

slowly to the surface and filters into the ground, as does also that which falls directly upon the soil and goes to feed the springs. This more especially takes place when the forests completely cover a soil that is mellow and rich in humus. It is difficult to explain this numerically, as no data have been collected, but the statement agrees perfectly with the experiences of the older inhabitants in mountainous regions, and its correctness cannot be doubted. The canton of Appenzal, however, furnishes records showing that the waters of the Weiseubach formerly did not rise at Weisenbad after great storms until three hours afterward, while this phenomenon now occurs half an hour after. If this occurs in a case like this, where the upper country is partially wooded, it should occur in much greater degree in countries that are entirely cleared.

2. The fact is not denied that brooks and rivers carry nowadays a larger amount of *débris* than formerly, in consequence of the great clear cuttings and extensive thinning of woods. The waters flowing rapidly, carry along all the loose earth, and wear ravines that extend from year to year. The beds of water-courses which are not rocky are worn and enlarged by the force of the waters that fall into their valleys, and often by the attrition of floating wood. The waters wash off upon the slopes a part of the fertile soil, forming gulleys, and often the entire slope may glide to the bottom, covering with its *débris* a large part of the valleys, rendering them incapable of cultivation. Many cases of this are seen in all valleys, as on the right bank of the Linth and Seetz, the south slopes on the Rhine, all the valleys in the southern Alps, and in those of the Reuss, Aar, and Rhone. In the more southern parts, which are the most cleared, if instead of gneiss which resists this action, we meet with shales or slates that are easily worn away, the devastation becomes so great that the inhabitants have been driven from the country.

3. This irregular flow of water, and damages to the fertility of the valleys, increase daily, and the sad effects above indicated are uniformly caused by inconsiderate clearings on the mountains. The *débris* brought in by the streams encumber the main channels, in which the descent may not be sufficient to allow of its being carried down, so that the waters are forced to seek new beds; fertile lands are buried, and whole valleys are transformed into desolate wastes of rocks and rubbish. These disasters not only affect the mountaineers, but likewise those dwelling in the fertile valleys below, whose estates become only great receptacles for the deposit of these transported materials. The damages to the lower valleys consist in the inundation of lands adjoining the streams, and injuries to the banks, and these overflows cause greater damages as the channels become filled up so that the waters cannot flow freely. The mountain cantons are therefore not the only ones interested in knowing whether we should not improve our forest economies not only in the mountain regions, but throughout the whole country.

We have only too many examples of these deplorable results. The Rhine, the Moesa, and all the streams in Tessin that fall into Lake Maggiore, and in particular the Maggia, the Reuss, the Aar, and the Emme, as also the Rhone and other streams of less extent, demonstrate this fact so clearly that no doubts can be raised as to the cause and manner of the process. The lands laid waste in the finest valleys of Tessin, in consequence of these irregularities in the water-courses, form nearly half of the whole of the valley lands. These devastations are the most considerable that are found in Switzerland, because the clearing off of the forest began earlier, and went on more rapidly, than in other sections of the country.

4. The dikes raised at great expense, along the banks of the principal water-courses, are in no case a success, as the works have been almost always ruined by the waters soon after being finished. This was not because of defective construction, nor imperfect general plan, but because instead of undertaking to cure the evil at its source we have, on the contrary, gone on continually clearing off the forests, and have taken no care for their preservation. The works undertaken in the lateral valleys have failed, because they have soon filled up with the *débris*, and have prevented the water from clearing out its bed. The reports of the engineers charged with the hydraulic part of this inquiry, will give the necessary details.

5. The many places where the soil becomes unfertile, as well on the mountains as in the valleys, diminish materially the production, and change the aspect of the country. These changes are almost entirely due to the inconsiderate clearing off of forests. We do not pretend that they may not occur in some degree without these clearings, but they are very greatly aggravated by this cause.

6. The clearing off of mountains arrests the development of industries, and renders the introduction of those that require wood impossible, because—

a. Most industries can only prosper in countries where they can easily obtain the fuel that they need.

b. The slight security which the banks offer, renders it difficult even in mountainous regions, to establish mills using water-power.

c. We cannot use water as a motive power to advantage, even on the plains, where it can be brought from the mountains, unless we have lakes as reservoirs, on account of the irregularities in the levels, which prevent regular operations.

Security to the climate—pleasant aspect of the country.

1. Avalanches have become more frequent since the clearing off of forests, and they now occur in localities where they formerly seldom happened. They endanger the safety of houses and roads, and do great injury to real estate. Replanting along their course is difficult or quite impossible, and the productive power of the soil is greatly reduced or wholly ruined throughout the track they have made in passing, or where they have left their *débris* of rocks. Clearings in the upper regions of the forests increase these disasters, and favor the formation of avalanches in places where the timber is not allowed to remain. When they begin to form at great elevations they are not checked until they have acquired a great impulsive force, and when this is obtained a forest, however vigorous, affords no obstruction.

2. The fall of rocks and stones, which is alike dangerous and injurious to the soil, may not be materially increased by clearings, but becomes more injurious because the *debris* which had formerly been stopped by the woods rolls farther down until it comes to rest upon valuable land, and sometimes threatens houses and roads.

3. Aqueous precipitations, if not diminished in amount, become at least more irregular. The rain, instead of falling gently, soaking gently into the soil, and imparting fertility, will oftener come in storms because we have too much reduced the amount of forests, which serve as a conductor of electricity and form a quite regular reservoir of moisture, beside checking the surface-currents of the air and warm and drying winds. The general fertility of the alpine region has been reduced by these various causes. Bushes have taken the place of pastures, and changes in the manner of using the alpages [vacant lands of the Alps] have extended their limit farther down. We cannot furnish upon these points numerical statements, but the complaints raised in all parts, and the opinion of intelligent inhabitants upon the Alps, give to this observation a degree of complete certainty. If any one has still any doubts upon this point, a single fact may convince them. Many pastures are now insufficient to feed the cattle that are turned upon them through the field season, although fewer head are kept, and the pastured area is constantly increased at the expense of the forests, so that these pastures are gradually approaching the valleys. It is pretended that this fact is illusory, and reference is made to the fine meadows and pastures of the canton of Appenzall. We may, on the other hand, point to the torn and impoverished mountains of Tessin, and to the decayed pasturage of the central Alps, and should remark that the pastures of Appenzall do not belong to the Alpine region, and that they have a good location.

4. It is impossible to suppose, in the absence of all proofs in this regard, that the climate should become worse from external physical causes, independent of man, and to which he could oppose no resistance. The diminution of several glaciers, of which the increase or decrease corresponds with cold or warm years, speaks rather against this hypothesis than in its favor. The fertility of the alpages has diminished; their upper limit has been lowered; the forests have disappeared in the upper regions; the climatic conditions have become less favorable to vegetation; the devastations caused by the waters, and by avalanches and falling rocks, have become more frequent and considerable, as have also the sliding of soil upon the slopes, and the accumulation of *debris* in the valleys. Such is the long list of calamities due to man's selfishness and his contempt of the laws of nature in working the forests in a heedless manner, and destroying them with criminal improvidence. The chastisement for this we already feel, and it will be more severely felt in the future.

5. Many countries have lost by the clearing off of their forests those traits which made them places of resort on account of their beauty. The traveler who has been delighted with the view of the beautiful green foliage of the spring or summer, or with the varied tints of autumn, will often observe now, in these same places, only arid slopes, torn and furrowed with ravines, or thinly covered here and there with scattered tufts of herbage, which scarcely feed the cattle that are pastured upon them, or overrun with brambles, broom, and rhododendrons. He will see only stinted briers or worthless myrtles, growing among the bleached trunks which bear witness to the splendor of a former vegetation, in the places where he expected to meet magnificent forests of fir and the somber shades of evergreens. Instead of the massive woods which adorned the crests and brows of the mountains, within the limits of tree-vegetation, he will often see only meager pastures or naked rocks; and in the valleys he will find great masses of materials rolled from above, instead of the meadows which formerly adorned them. Such are the contrasts that sadden the traveler and cause a painful impression, even in the inhabitants who have become accustomed little by little to these melancholy changes.

6. The forests of a part of the country that we occupy, and especially in Tessin, a region so rich by nature, are going on to total ruin, if we do not prevent it by an improvement in their management, and fix a limit in working at the amount they are able to yield. It will happen here as it has already in the Karst, in Illyria, formerly so well timbered, or in the regions in Asia Minor and Greece, in a part of Italy, and

in the south of France. But these conditions may prove less endurable with us, where the climate is ruder and colder than in those countries. The cultivation of the soil may become impossible, the population considerably diminished, and the elevated parts of the mountains now inhabited may become altogether desolate.

The active efforts of the Swiss Forestry Association and of intelligent persons throughout the country led, some years later, to an amendment to the Federal constitution, which was sanctioned April 19, 1873, and provided as follows:

XXII. The Federal Union has the right of supervising structures for the protection of water-courses, and of the forest police in the mountain regions. It will assist in the improvement and building of protective structures for water-courses, and in the planting of forests at their sources. It will enact the requisite protective regulations for maintaining these works and the forests now existing.

XXIII. The Federal Union is authorized to enact regulations for governing fisheries and hunting, and make particular provision for the preservation of the mountain game, and also for the protection of birds useful to land and forest culture.

This change did not contemplate interference with the laws previously existing in the several cantons, except in so far as the public welfare of the country might require. This community of interests has at length led to the passage of the following important law, which dates from March 24, 1876, and forms a new era in the forestal history of this country:

Federal law relating to the high surveillance of the Confederation over the police of forests in the elevated regions.

I. GENERAL PROVISIONS.

ARTICLE 1. The confederation will exercise high surveillance over the police of forests in the zone of elevated regions in Switzerland.

ART. 2. This surveillance will extend—

(1) To the whole territory of the cantons of Uri, Unterwalden, Glaris, Appenzell, Grisons, Tessin, and Valais.

(2) To the mountainous part of the territory in the cantons of Zurich, Berne, Lucerne, Schwytz, Zug, Freyburg, St. Gall, and Vaud. In these latter cantons, the federal council will fix, in concert with the governments interested, the limits of alpine regions which shall be placed under the high surveillance of the confederation. If the federal council and the cantonal government cannot agree upon the subject of forestal limitation, the federal assembly shall decide.

ART. 3. Within the limits of the federal forestal zone, all forest protection shall be under the high surveillance of the confederation.

The State forests, and those belonging to communes and corporations, are subject to this supervision, the same as if other means for protection were not provided.

The articles 11, 14 (clauses 2, 3, and 4), 15, 20, and 27 (Nos. 2, 4, 8, and 9), of the present law, are only applicable to forests owned by individuals, which are not of the character of forests for protection.

ART. 4. Forests for protection are those which by reason of their altitude, or of their location upon steep slopes, culminating points, ridges, mountain-brows, or projections, or in the region of springs, or in ravines, or on the banks of streams and rivers, by reason of the insufficient wooding of the country serve as a protection against climatic influences, or injuries from winds, avalanches, the fall of stones or ice, abrasions or slidings of soil, the wearing of ravines and inundations.

ART. 5. The cantons shall, within two years, cause a determination to be made between those forests which are a protection and those which are not. This operation shall be submitted for examination and sanction by the federal council.

ART. 6. The cantons shall issue the decrees and ordinances necessary to carry this law into effect, and shall submit a copy thereof for the examination and sanction of the federal council.

The federal council will supervise their application, and to this end will appoint a forest inspector, to whom shall be furnished a sufficient number of assistants.

II. LIMITATIONS AND PERSONAL DUTIES OF THE FOREST SERVICE.

ART. 7. The territory of cantons and parts of cantons included in the federal forest zone shall be divided into cantonal governments for the better organization of the forest service.

ART. 8. For the execution and application of forest laws, the cantons shall appoint and provide for the necessary number of foresters sufficiently educated for their duties.

ART. 9. The cantons are required to organize under a course of sylviculture such subordinate employés qualified for these duties as may be found necessary.

III. ARRANGEMENTS CONCERNING THE PRESERVATION OF FORESTS, AND THE CONDITIONS IMPOSED UPON THEIR OWNERS.

ART. 10. All forests placed under the high surveillance of the confederation (Art. 3), shall be marked out within a period of five years at most. Whenever a massive forest is composed of parcels belonging to different owners, it will be sufficient to mark its outer limit only.

ART. 11. Within the limits that may be fixed, there shall be no diminution *without permission of the cantonal authorities*, and all cuttings and clearings that may be hereafter worked shall be reforested, unless an equivalent area of other land not in forest is planted.

All clearings are prohibited under the following conditions:

(1) In forests of protection;

(2) Whenever they might endanger such protecting forests.

Exceptions may be made from these rules whenever specially authorized by the federal council.

ART. 12. All actual partitions of rights of property, or rights of usage concerning forests owned by the state, by communes, and by corporations are forbidden, unless in exceptional circumstances, and with the knowledge of the cantonal government.

ART. 13. The forests belonging to communes and corporations shall not be alienated without permission of the cantonal government.

ART. 14. The rights of range, of gathering nuts, and all other rights which bear upon protecting forests (Art. 4), shall be redeemed, if incompatible with the object for which such forests are maintained. This redemption shall be made within a period of ten years at most.

The rights of usage of wood, which bear upon forests subject to the high surveillance of the confederation, shall be redeemed out of the proprietary fund. The indemnity may be paid in money, or, if circumstances prevent, by the surrender of an equivalent parcel of land of the same quality.

The cantonal legislatures shall fix the mode of acquiring these franchises, and the proceedings to be had in redeeming the rights above mentioned.

The forests shall not be burdened with new servitudes of this kind.

ART. 15. All acts done contrary to articles 12, 13, and 14 are void.

IV. PROVISIONS FOR MANAGEMENT—CREATION OF NEW FORESTS.

ART. 16. There shall be prepared a plan of the forests owned by the State, by communes, and by corporations, to the end that they may be properly managed and their working regulated. The annual capacity of the forest shall be determined and founded upon a report made. This shall not be exceeded, unless by authorization of the cantonal government.

If from exceptional circumstances or illicit working the fixed limit be surpassed, the cuttings for the following years shall be reduced in a corresponding degree.

ART. 17. In forests where for the time being definite plans of management shall not have been promulgated, there shall be prepared a provisional plan of working to fix the limit of annual capacity, as well as a mode of utilizing the regeneration and cultivation of the forests.

ART. 18. The cantons shall be allowed to regulate the working of forests belonging to individuals within the limits of the present law.

ART. 19. The cantonal governments are required to take the measures of administration and police necessary to secure the preservation of protecting forests (Art. 4), and to realize the end for which they are established.

ART. 20. The incidental usages practiced in these forests which tend to injure good management, such as the range of large or small cattle, the collection of nuts, leaves, &c., shall be regulated by the cantons, or, if need be, suspended or suppressed. Such incidental usages as are admissible, absolutely or conditionally, shall be regulated in the interest of good management.

ART. 21. Such land as might be used for establishing important forests of protection, in the sense specified in Art. 4, shall be planted in forest, upon demand of the cantonal government or of the federal council.

The canton and the confederation shall contribute to the cost of first planting, and, if the federal council deems it proper, to the work of amelioration that may be necessary in the course of the next four years, when there has been no fault on the part of the proprietor.

ART. 22. If the land to be planted with forest belongs to an individual, the canton has a right to demand, and the owner is held to give, the price for absolute sale, in accordance with the federal law of May 1, 1850, providing for the extinguishment of title for the public use.

V. CONCERNING FEDERAL SUBSIDIES.

ART. 23. The confederation will assist the course of sylviculture above required, in accordance with article 9, and organize it in concert with the cantons.

ART. 24. The confederation will also assist:

(1.) The creation of new forests. (Articles 21 and 22.)
(2.) The reboisement of protecting forests (Article 4) so far—
a. As they may be of great importance as a security against accidents to the land; especially if they are in co-relation with works for protection.
b. As the reboisement may present great difficulty in execution.

ART. 25. The federal council will fix the amount of subsidy, taking into account the amount carried to the budget, within the maximum and minimum limit as follows:
(1.) From 30 to 70 per cent. for the expense of creating new forests. (Article 24, No. 1.)
(2.) From 20 to 50 per cent. for planting in the cases mentioned in No. 2, article 24.)
These subsidies shall not be granted when they relate to forests owned by the State.
The federal council will not pay these subsidies to cantons until it is assured by the report of the federal inspector of forests that the work has been done in accordance with the rules prescribed, and that the calculation of cost is correct.

ART. 26. In receiving the subsidy, the canton engages with the confederation to take care of and preserve the forests planted, and to execute the improvements that may become necessary.

VI. PENAL REGULATIONS.

ART. 27. Those violating the regulations embraced in the present law shall be liable, besides damages, to the following fines:
(1.) For not defining boundaries, as prescribed in article 10, or in hindering the same, 5 to 50 francs.
(2.) For reducing the forest-area without permission of the cantonal authorities (article 11), 100 to 200 francs per hectare. The land so cleared shall be replanted within one year.
(3.) For division or sale of forests without cantonal authority (articles 12 and 13), 10 to 100 francs per hectare.
(4.) For constituting new servitudes (article 14), 10 to 100 francs.
(5.) For contravention of rules prescribed for definite or provisional management, if the particular fines are not already fixed (articles 16 and 17), 20 to 300 francs.
(6.) For unlawful cuttings in any of the forests submitted to the high surveillance of the confederation (articles 16, 17, 18, and 19), 1 to 10 francs per cubic meter (actual measure).
(7.) For non-observance of the other rules contained in articles 19 and 20, in respect to protecting forests, 10 to 100 francs.
(8.) For non-execution of planting ordered in said forests (articles 11 and 21), 20 to 100 francs per hectare.
(9.) For incidental workings made contrary to prohibition or to the terms of the present law (article 20), 5 to 500 francs.
The inquiry and judgment in the case of these violations of law, as also the application of the fines, is left to the cantonal authorities.

ART. 28. If a land-owner persists in refusing to execute the work prescribed, it may be done by the cantonal government at his expense.

ART. 29. The cantons shall take the measures necessary in the case of forest-damages, fires, injuries from winds, damages from insects, and the like. They shall enforce the penalties which they establish.

VII. TEMPORARY AND FINAL REGULATIONS.

ART. 30. So long as the present law may remain not fully applied in certain cantons, and especially until the officers of which it contemplates the employment are provided the federal council undertakes, according to its urgency, to watch over the preservation and management of the forests submitted to its high surveillance.
The cantons interested are held to reimburse the extra expenses which through this cause may be incurred by the confederation.
The federal council will fix, for each canton in particular, the time when these temporary regulations shall end. Until then, the requirements of cantonal laws concerning clearing shall remain in force, subject, however, to the approval of the federal council.

ART. 31. The federal council is charged, in accordance with the provisions of the federal law of June 17, 1874, relating to the popular vote upon federal laws and decrees, to publish the present law, and to fix the time when it shall take effect.

As a means for carrying the above law more effectually into operation, a regulation was issued September 8, 1876, at the request of the Department of the Interior, granting aid for the holding of courses of instruction in the different cantons, of not more than two months in each year, in sessions of one month each. The instruction given at these gatherings, which are designed for young men at least eighteen years of age, is to be almost wholly practical, no time being spent upon

theories beyond the limit necessary for understanding the execution of practical labors.

The course is to embrace the following subjects:

1. Forest-surveys; the marking out of woodlands; measurement and calculation of small areas, as also of the trunks of trees, linear distances, &c.; estimation of single trees and parcels of forest, as to quantity and value; making of forest-roads; means of shielding forests against avalanches and smaller slides.
2. Study of the kinds of wood and of injurious herbs that should be known by sub-foresters.
3. Elementary study of the soil, and of the relations between different kinds, and of the nature of different tracts of land.
4. Indispensable ideas of climatology and meteorology.
5. Cultivation and management of forests.
6. The information most important to subforesters concerning the working of forests, forest-police and protection, and book-keeping.
7. The number of pupils shall not exceed thirty.

The applicants must be examined in the primary studies as taught in the best schools, and, at the end of the course, and if approved, a certificate is given. The instructors are appointed by the cantons, subject to approval of the central authority, and their pay is provided for out of the general treasury.

Under regulations of the same date, the mode of making application for the establishment of new forests, and for planting forests for protection, is defined. It must be accompanied by a detailed statement of the place, names of proprietors interested, an indication of the kind and extent of the work desired, and other details sufficient to enable the central authority to understand the case. The federal government grants aid for reboisement and works of defense, which is paid only after completion, but it will not entertain claims exceeding first estimates. The cantons, on receiving this subsidy, engage on their part to carefully protect the work done, and to execute such works of repair or improvement as may be necessary.

The report of the Department of the Interior, made in April, 1874 (p. 52), shows that labors of improvement and reboisement had been carried on upon a large scale in the canton of Grisons.

In the case of planting for protection, however, the attempts made in most localities were as yet too timid and incomplete, as compared with strictest necessity, to justify hopes of notable success, and in places where there was the most urgent need nothing had been done.

ITALY.

Recent law for reboisement.

On the 20th of June, 1877, a law took effect in the Kingdom of Italy, for regulating the planting or clearing of woodlands, where the public welfare required, and for relieving such lands from servitudes and rights of usage where the exercise of these rights interferred with the principal object sought to be attained. The fact is recognized in that country, as elsewhere, that forests in mountainous regions have suffered greatly from abuse of pasturage, and that nothing short of the energetic measures provided in this would rescue the country from the evils that might attend the wasting of forests, where their presence was necessary, as in cases mentioned in the the first articles of this law.

TITLE I.—*Concerning the lands submitted to forest-regulations.*

ARTICLE 1.—The following lands shall be considered, for the purposes of the present law, as subject to forest-regulation, viz: Forests and lands

cleared of woods on the tops and slopes of mountains to the upper limit of the chestnut zone, and which, from their nature and location, might occasion injury, slides, erosions, avalanches, &c., or that might modify the water-courses, and alter the consistence of the soil, or local hygienic conditions.

ART. 2. The submission, by reason of public health, shall not be imposed, excepting in woods actually existing, and according to advice agreed upon by the communal or provincial council interested, and by the provincial sanitary council.

In all cases, in the provinces where the woods are not subject, under existing laws, to restrictions having reference to the public health the commune or province claiming the application of these restrictions should properly indemnify the proprietors.

ART. 3. The terms of the present law shall not apply to lands sufficiently protected, or held by dikes, nor to those cultivated in vines, olives, and other arborescent plants or fruits.

ART. 4. It is forbidden to cut off the wood or to clear the lands specified in article 1, notwithstanding which, authority for bringing under cultivation shall be granted in case the proprietor shall employ effectual means approved by the forest committee, and by the provincial sanitary council, for preventing all damages that might happen.

Forest-culture and the cutting of woods shall not require previous authorization, provided that the proprietors conform themselves to the rules established by each forest-committee. These rules shall have for their object the maintenance of the soil, the reproduction of forests, and their preservation in cases where the public health is concerned.

ART. 5. There is established in each province a committee composed of the prefect of the province (who shall act as president), the inspector, or, in his absence, a subinspector of forests, an engineer, appointed by the Minister of Agriculture, Industry, and Commerce, and three members elected by the provincial council. The council of each commune in the province shall nominate a member, who shall take part with a vote in the labors of the committee, but only in what concerns the territory of the commune which he represents.

The engineer appointed by the ministry, and the members elected to the committee, shall hold their offices for two years, but they shall always be re-eligible.

ART. 6. Within six months after the publication of the present law, the forest-inspectors shall prepare and present to the forest committee a distinct statement for each commune of the woods and lands subject to the terms of forest laws actually in force, and which ought to be freed from the conditions imposed under the present law.

The committees after being assured, if necessary, of the conditions of the case, and hearing the sanitary provincial council, as in cases provided for by the second paragraph of article 1, shall decide within six months upon the propositions, and within this time publish them in all the communes of the province. The clearing of forest servitudes becomes absolute fifteen days after the publication of these tables.

ART. 7. Upon the proposal of the forest administration of communes and provinces, the committee shall proceed to ascertain concerning the lands that may be found within the conditions provided in article 1 of the present law in whatever relates to water-courses and the maintenance of the soil, and as to such as should not be subjected to these regulations. After this determination the committee shall take action upon the proposition. The necessary expenses incurred in the pro-

ceedings mentioned in the present article shall be charged to the state account.

ART. 8. The forest administration shall, as soon as these decisions are made, publish in each commune of the province tables of the woods and lands placed under these regulations. Within two years after this publication those interested may apply to the committee to ask for their release. The committee shall ascertain by an examination of the places, and shall decide upon the request. The cost of ascertaining shall be paid by those interested.

ART. 9. When, in consequence of works of conservation or repair deemed sufficient for this end, or from any other reason, the causes for which a tract of land have been submitted to the operation of this law have ceased, the committee, either upon its own accord, or upon a request of interested parties, shall decide after due investigation upon clearing it from these restrictive regulations.

ART. 10. All persons interested shall have a right to appeal from the decisions of the committee to the council of state, who shall decide after hearing the observations of the forest council, and if necessary those of the councils of public works and of health.

TITLE II.—*Reboisement.*

ART. 11. The Ministry of Agriculture, Industry, and Commerce, the provinces and the communes, for the purpose of maintaining the soil, and of regulating water-courses, may either jointly, or without consulting the others, undertake the reboisement of lands submitted to regulation.

The direction of works of reboisement undertaken at the expense of the government, the provinces, or the communes, is intrusted to the forest committee. A section in the appropriations to the Ministry of Agriculture, Industry, and Commerce shall provide for the cost of reboisement made on state account.

ART. 12. The State, the provinces, and the communes are authorized to proceed according to modes established by existing laws for the setting apart, upon the ground of public utility, the lands above mentioned.

The proprietor, on his part, shall have the right of cultivating in a manner that may satisfy the object of the present law the land designated as under regulation, provided that he makes a declaration before the beginning of his labors that he will undertake them within six months, and that he will finish them within the time that may be fixed by the forest committee.

The forest administration shall be authorized, under appropriations made for this object, to acquire vacant lands, either for reboisement or for sale, when the purchaser will take charge of reboisement.

ART. 13. The proprietors of lands submitted to forest obligation may form a company for the purpose of replanting their lands, and for their preservation, and for the protection of their rights. The formation of these companies may also be ordered by judicial authority, upon the request of a majority of those interested, when needed for the maintenance and defense of their common rights. The dissenting owners may free themselves from this obligation, by ceding their lands to the company at an estimated price, and in this case the latter are bound to purchase them.

ART. 14. When the matter relates simply to the work of reboisement, the company shall have a right to proceed according to the method laid down by the law to the setting apart of the lands within the limits desig-

nated for reboisement, although the owners of land have refused or do refuse to take part in the company, unless proof is obtained that forest-culture cannot be done without the aid of those dissenting, or of those who are to be benefited by this cultivation. This right of setting lands apart, however, shall not be exercised except in cases where those acting own at least four-fifths of the lands embraced within the limits to be planted.

ART. 15. The provisions of articles 3, 4, 5, 6, and 7 of the law of May 29, 1873 (No. 1387, series 11), shall apply to companies formed under article 14 of this law.

TITLE III.—*Penal provisions and forest-police regulations.*

ART. 16. The proprietor who shall clear or cut off wood, or who, having cleared and cut off in violation of law, shall continue to cultivate a piece of land submitted to these regulations, or who shall not execute the labors mentioned in article 4, shall be subject to a fine of not exceeding 250 liras per hectare, and he shall be obliged to have his land replanted within six months after rendering of judgment.

ART. 17. If the land is not within six months after sentence sufficiently prepared for sowing or replanting, or if the labors mentioned in article 4 are not executed, the prefect of the province shall cause a plan of the necessary works to be prepared by a forest agent. Within a month after notice of this proceeding the delinquent shall deposit with the clerk of the prefectory a sum equal to estimated expense, and the forest committee shall cause the works to be directly done. If this deposit is not made, or if the estimated cost is not sufficient, a recovery may be had of the sum due, upon an order of the prefect, according to the rules established for the recovery of direct assessments.

ART. 18. The private owners of woods submitted to these forest restrictions, who shall violate the rules prescribed by the forest committee mentioned in article 4, shall be punished by a fine of double or quadruple the value of the wood cut, or of the damage done.

ART. 19. Administrators of official trusts shall incur the highest penalty named when they render themselves liable by intentional violation of the preceding article, and will be further liable to the penalties that they would have incurred had they committed these acts for their personal gain.

ART. 20. Transgressions mentioned in articles 16 and 18, committed by persons other than proprietors or public officers, shall be punished not only by the penalties specified in these articles, but also by personal punishment inflicted under the general penal laws when these acts constitute a crime within the meaning of these laws. The fines for offenses mentioned in article 16 shall not be less than three-fifths of the greatest, and for other offenses not less than two-thirds of the damage done to contractors of cuttings, or those hiring pasturage, and generally to those who had the right of the use of the woods. The fine shall not be less than sextuple of the damage in the nurseries and sowings done by the forest administration.

ART. 21. The valuation of wood cut and of damage done shall be made by the forest agents under rules that shall be prepared for general regulation in the execution of the present law. The parties interested may be heard upon the estimate of the forest agents before the judicial authorities. Beside the penalties provided in the preceding article, the judgment may order the payment of damages to the benefit of parties to whom they may be due.

ART. 22. If from any cause whatever the penalties provided for under the present law shall come within the sphere of existing general penal laws, and if the penalties decreed by these laws are more severe, the latter shall be applied without abatement in the least degree, save only as regards the provisions of article 20.

ART. 23. The pecuniary fine established by the present law shall, in case payment is not made, be changed to imprisonment or arrest, according to its importance, and within limits established by the penal code.

ART. 24. The forest committee shall propose in each province the necessary forestal police regulations. These shall be approved by the provincial council, and validity will be given by the ministry of agriculture, industry, and commerce, whatever they may be. After a hearing, the council of state may annul such portions as are contrary to the object and to the arrangements of the present law, or to general regulations.

ART. 25. The violation of rules of the forest police shall be punished in such manner as the penal laws provide.

TITLE IV.—*Forest administration.*

ART. 26. The pay of officers and forest guards shall be borne by the State. Expenses relating to the personal support of the guards shall be two-thirds at the cost of the communes and one-third at the cost of the province. The provincial council, upon the advice of the forest committee, shall determine the amount of pay, the number of guards, and the division of the expenses.

ART. 27. Forest guards shall be placed upon the same footing as those of the customs, so far as relates to article 18 of the law of May 13, 1862.

ART. 28. Forest agents shall be deemed officers of the judicial police, conformably with the rules of the code of penal procedure, and for the maintenance of the public laws.

TITLE V.—*Of rights of usage.*

ART. 29. No rights of usage should be granted, beyond the terms of article 521 of the civil code, upon the lands mentioned in article 1 of the present law.

ART. 30. All those who claim to have rights of pasturage or other rights of usage, upon lands submitted to regulation by virtue of the terms of the present law, should make, within two years after its publication, a declaration setting forth their title, or their means of justification, to the secretary of the civil and correctional tribunal in the district within which the properties burdened with these rights is located. This declaration should be given to the communal secretary, who will forward it to the secretary of the tribunal. At the end of the time above indicated, the owner of the property should prevent, by legal means, the exercise of this right by those who have not made this declaration. Within the six months following the day when this prohibition is made, the user has the right of filing his declaration, upon paying a fine of from 5 to 25 liras. When this time is elapsed, those who have made their declaration may exercise their rights, while the rest shall be deprived of all rights.

ART. 31. Upon citations issued at the instance of the more diligent parties, the civil and correctional tribunal shall proceed in a summary

way to judge, saving right of appeal, upon the reality of the rights claimed, and if affirmed, they shall fix their nature and limits.

ART. 32. If these rights of usage are exercised or held by the entire commune or by parts of a commune, these communes or parts of communes shall be represented in the proceedings that may be had before the judges by the officers of these administrations.

In these cases the declarations prescribed by article 30 are to be made by the latter. The privilege of having his own rights represented is reserved to each user. In case of tardy declaration, the officers of the commune shall be personally answerable for the damage caused to those whose interests they represent.

ART. 33. The State (except as to the terms of the law of November 1, 1875, No. 2794, second series) communes, and other corporate bodies, as well as individuals, may clear their woods and other lands from rights of usage mentioned in article 29 and following.

ART. 34. By means of conferences had with the parties interested, the clearing of these rights shall be accomplished by allowing in full payment to those holding them a value equal to that of the right suppressed, or a payment of the amount in money.

In case the use of pasturage or of other rights of usage are recognized as wholly or in part necessary to a population, the Ministry of Agriculture, Industry, and Commerce, after hearing the communal council, the forest committee, and the council of state, may suspend for such a time as it may deem necessary the right of suppression, but it shall regulate the exercise of these rights thus continued.

ART. 35. Requests in these proceedings should be addressed to the prefect, who, after hearing the forest committee, shall endeavor to conciliate the parties interested, but failing in this, it shall be referred to the ordinary tribunals, who shall proceed in summary manner.

Transitory provisions.

ART. 36. In those provinces where there is no forest law, the terms of article 7 of the present law shall be applicable as soon as the Government shall have obtained information by reports from provincial and communal authorities.

ART. 37. The prohibition against clearing shall not apply to lands comprised within the zone above the chestnut, where they are already under cultivation, except as article 7 applies.

ART. 38. The forest committee established by the present law will take the place of the commission mentioned in article 2 of the law of July 4, 1874 (No. 2011, second series).

ART. 39. Regulations to be made—the council of state being heard—shall fix the rules to be followed, as instructions for claims, and providing for all other concerns that relate to the execution of the present law.

TIMBER RESOURCES OF THE UNITED STATES.

CENSUS STATISTICS OF FORESTS AND FOREST PRODUCTS.

1. *General remarks.*

The only means hitherto existing for determining the amount of timber-lands within the United States, and the principal facts concerning the manufacture of articles wholly or partially of wood, has been the national census. In some of the States, however, a census is taken, generally, at intervals of ten years, and alternating with the decennial census of the general government, and several of these afford more detailed information. Although these enumerations involve errors in particular cases, an excess in one instance may sometimes be reduced by an omission or an underestimate in another. These errors may be supposed to be somewhat uniform in their character, and not necessarily greater at one period of time or in one State or section of country than another. The statistics of the census are for general purposes comparable with one another, when taken under uniform instructions, and may be regarded as approximately near the truth, the general tendency, however, being always to under-estimate, rather than to exceed.

In many instances the inquiries of the enumerators are suspected as intended to form a basis of taxation, and many facts may escape record altogether, while the motives for exaggeration could seldom exist.

We will present the general results relating to forest-products and industries depending upon them, in the order of time, and as concisely as appears practicable.

2. *Attempts to report statistics of industries in* 1810 *and* 1820.

1810.—The first attempt to collect these statistics by the census, was in 1810, when under an amendatory act passed May 1, 1810, the marshals were instructed to procure such statistical information as the Secretary of the Treasury might direct. The returns were meager and not comparable, except from Pennsylvania, where the returns from saw-mills were reported with apparent fullness. This interesting statement is given in connection with our notice of that State.

1820.—The census of 1820 undertook in a very careless way, to report manufactures, but there was no attempt made to summarize by States, and the item of lumber was but seldom reported from counties. This failure apparently discouraged any attempt at procuring industrial statistics in 1830.

3. *Census of* 1840.

The census of 1840 obtained statistics of the lumber trade as a branch of commerce and as a manufacture. These, as returned by States, were as follows:

(a.) *Lumber yards and trade*, 1840.

States and Territories.	Lumber yards and trade.	Capital invested.	Men employed.	States and Territories.	Lumber yards and trade.	Capital invested.	Men employed.
Alabama	9	$1,800	73	Mississippi	11	$132,175	228
Arkansas	9	12,220	263	Missouri	45	318,029	345
Connecticut	57	438,425	582	New Hampshire	9	29,000	626
Delaware	22	83,280	140	New Jersey	86	410,570	1,280
District of Columbia	11	140,000	49	New York	414	2,694,170	9,592
Florida (Territory)	16	64,050	92	North Carolina	20	46,000	432
Georgia	26	75,730	442	Ohio	78	373,268	2,891
Illinois	39	93,350	405	Pennsylvania	284	2,241,040	5,064
Indiana	37	90,374	767	Rhode Island	41	254,900	262
Iowa (Territory)	3	16,250	29	South Carolina	14	100,000	1,057
Kentucky	95	105,925	571	Tennessee	9	6,700	1,126
Louisiana	121	260,045	597	Vermont	14	45,506	321
Maine	68	305,850	2,068	Virginia	41	113,210	1,454
Maryland	48	307,300	1,330	Wisconsin (Territory)	14	21,180	133
Massachusetts	137	1,022,360	3,432				
Michigan	15	45,600	312	Total	1,793	$9,848,307	35,963

(b) *Products of the forest*, 1840.

States and Territories.	Value of lumber produced.	Barrels of tar, pitch, turpentine, and rosin.	Tons of pot and pearl ashes.	Skins and furs, value produced.	Ginseng, and all other forest products, value.	Number of men employed.
Alabama	$169,008	197		$3,585	$4,281	84
Arkansas	176,617	34		37,047	3,805	343
Connecticut	147,841			19,760	13,974	120
Delaware	5,562				7,557	
District of Columbia						
Florida (Territory)	20,346			7,004		6
Georgia	114,050	153		2,928	155	221
Illinois	203,666		½	39,412	6,763	368
Indiana	420,791		2	220,883	9,902	799
Iowa (Territory)	50,280	25		33,594		67
Kentucky	130,329	700		17,860	34,510	508
Louisiana	66,106	2,233		1,179		54
Maine	1,808,683		260¾	8,027	32,271	2,892
Maryland	226,977			2,527	11,690	115
Massachusetts	344,845		6	60	31,669	174
Michigan	392,325		145	54,232	6,483	320
Mississippi	192,794	2,248		3,382	6,873	123
Missouri	70,355	356		373,121	4,015	1,134
New Hampshire	433,217		113½	2,923	1,929	553
New Jersey	271,591	2,200	2	20,000	65,075	446
New York	3,891,302	402	7,613¾	15,556	143,332	4,664
North Carolina	506,766	593,451		3,126	46,040	2,694
Ohio	262,821	5,631	6,809½	37,218	15,206	326
Pennsylvania	1,150,220	1,595	263	9,571	14,297	1,988
Rhode Island	44,455				155	50
South Carolina	537,684	735		1,225	9,247	508
Tennessee	217,606	3,336	1	2,602	1,635	282
Vermont	346,939		718½	1,750	2,500	393
Virginia	538,092	5,809		23,214	49,654	2,218
Wisconsin (Territory)	202,239	1		124,776	3,562	593
Total	12,943,507	619,106	15,935½	1,065,869	526,580	22,043

The census of 1840 reported 8,229 tanneries, employing the labor of 26,018 men and $15,650,929 in capital. They produced 3,463,611 sides of sole-leather and 3,781,868 sides of upper leather, and, on a rough estimate, used at least half a million cords of bark. Among the industries consuming large amounts of timber and lumber, we find ships and vessels worth $7,016,094, and furniture worth $7,555,405, as made during

the year reported, the latter employing 18,003 men and $6,989,971 in capital. There were 8,429 houses built within the year of brick and stone and 45,684 of wood, employing the labor of 85,501 men and capital to the amount of $41,917,401.

4.—*Census returns of* 1850, 1860, *and* 1870.

As these census enumerations were all made under the same act, and by agents under nearly similar instructions, they may be shown somewhat in connection.

Area of forest land.—Before 1870, agricultural land was simply reported as "improved" or "unimproved," the latter term being altogether indefinite in its meaning, and alike including woodlands, prairies, and marshes. In 1870, an attempt was first made to separate this uncertain class into "woodlands" and "unimproved, not woodlands," but as lands not in farms were not included in the enumeration, and as the returns from some districts were very imperfectly made in this respect, the result is far from being reliable.

We present the general result by groups of States in the following table, and a comparison of the total area as reported by the census, with the areas of the States as generally allowed in geographical memoirs.

5.—*Comparison of forest areas—Census of* 1870.

States.	Total area as commonly reported.		Acres of land in farms.			Acres not included in returns.
	Square miles.	Acres.	Improved.	Unimproved, woodland.	Unimproved, not woodland.	
NEW ENGLAND STATES.						
Maine	35, 000	22, 400, 000	2, 917, 793	2, 224, 740	695, 525	16, 561, 942
New Hampshire	9, 280	5, 939, 200	2, 334, 487	1, 047, 090	224, 417	2, 333, 206
Vermont	10, 212	6, 535, 680	3, 073, 257	1, 386, 934	68, 613	2, 006, 876
Massachusetts	7, 800	4, 992, 000	1, 736, 221	706, 714	287, 348	2, 261, 717
Rhode Island	1, 306	835, 840	289, 030	169, 399	43, 879	333, 532
Connecticut	4, 750	3, 040, 000	1, 646, 752	577, 333	140, 331	675, 584
Total	68, 348	43, 742, 720	11, 997, 540	6, 112, 210	1, 460, 113	24, 172, 857
MIDDLE STATES.						
New York	47, 000	30, 080, 000	15, 627, 206	5, 679, 870	883, 734	7, 889, 190
New Jersey	8, 320	5, 324, 800	1, 976, 474	718, 335	294, 702	2, 335, 289
Pennsylvania	46, 000	29, 440, 000	11, 515, 965	5, 740, 864	737, 371	11, 445, 800
Delaware	2, 120	1, 356, 800	698, 115	295, 162	59, 045	304, 478
Maryland	11, 124	7, 119, 360	2, 914, 007	1, 435, 988	162, 584	2, 606, 781
District of Columbia	60	38, 400	8, 266	2, 428	983	26, 723
Total	114, 624	73, 359, 360	32, 740, 033	13, 872, 647	2, 138, 419	24, 608, 261
SOUTHERN STATES, ATLANTIC COAST.						
Virginia	38, 352	24, 545, 280	8, 165, 070	8, 294, 734	1, 686, 137	6, 399, 369
North Carolina	50, 704	32, 450, 560	5, 258, 742	12, 026, 894	2, 549, 774	12, 615, 150
South Carolina	34, 000	21, 760, 000	3, 010, 539	6, 443, 851	2, 650, 890	9, 654, 720
Georgia	58, 000	37, 120, 000	6, 831, 856	12, 928, 084	3, 888, 001	13, 472, 059
Florida	59, 268	37, 931, 520	736, 172	1, 425, 786	211, 583	35, 557, 979
Total	240, 324	153, 807, 360	24, 002, 349	41, 119, 349	10, 986, 385	77, 699, 277
SOUTHERN STATES, GULF COAST.						
Alabama	50, 722	32, 462, 080	5, 062, 204	8, 380, 332	1, 518, 642	17, 500, 902
Mississippi	47, 156	30, 179, 840	4, 209, 146	7, 959, 384	952, 583	17, 058, 727
Louisiana	41, 346	26, 461, 440	2, 045, 640	4, 003, 170	977, 007	19, 435, 623
Texas	274, 356	175, 587, 840	2, 964, 836	7, 662, 294	7, 769, 393	157, 191, 317
Total	413, 580	264, 691, 200	14, 281, 826	28, 005, 180	11, 217, 625	211, 186, 569

5.—*Comparison of forest areas—Census of* 1870—Continued.

States.	Total area as commonly reported.		Acres of land in farms.			Acres not included in returns.
	Square miles.	Acres.	Improved.	Unimproved, woodland.	Unimproved, not woodland.	
WESTERN STATES, SOUTH OF THE OHIO.						
Tennessee	45, 600	29, 184, 000	6, 843, 278	10, 771, 396	1, 966, 540	9, 602, 786
Kentucky	37, 680	24, 115, 200	8, 103, 850	9, 134, 658	1, 421, 598	5, 455, 094
West Virginia	23, 000	14, 720, 000	2, 580, 254	4, 364, 405	1, 583, 735	6, 191, 606
Total	106, 280	68, 019, 200	17, 527, 382	24, 270, 459	4, 971, 873	21, 249, 486
WESTERN STATES, NORTH OF THE OHIO.						
Ohio	39, 964	25, 576, 960	14, 469, 133	6, 883, 575	359, 712	3, 864, 540
Indiana	33, 809	21, 637, 760	10, 104, 279	7, 189, 334	826, 035	3, 518, 112
Illinois	55, 410	35, 462, 400	19, 329, 952	5, 061, 578	1, 491, 331	9, 579, 539
Michigan	56, 451	36, 128, 640	5, 096, 939	4, 080, 146	842, 057	26, 109, 498
Wisconsin	53, 924	34, 511, 360	5, 899, 343	3, 437, 442	2, 378, 536	22, 796, 039
Total	239, 558	153, 317, 120	54, 899, 646	26, 652, 075	5, 897, 671	65, 867, 728

States and Territories.	Total areas as commonly reported.		Acres of land in farms.			Acres not included in returns.
	Square miles.	Acres.	Improved.	Unimproved, woodland.	Unimproved, not woodland.	
WESTERN STATES (ADJOINING MISSISSIPPI, WEST SIDE).						
Arkansas	52, 198	33, 406, 720	1, 859, 821	3, 910, 325	1, 827, 150	25, 809, 424
Missouri	65, 350	41, 824, 000	9, 130, 615	8, 965, 229	3, 611, 376	20, 116, 780
Iowa	55, 045	35, 228, 800	9, 396, 467	2, 524, 793	3, 620, 533	19, 687, 007
Minnesota	83, 531	53, 459, 840	2, 322, 102	1, 336, 299	2, 825, 427	46, 976, 012
Total	256, 124	163, 919, 360	22, 709, 005	16, 736, 646	11, 884, 486	112, 589, 223
INTERIOR STATES AND TERRITORIES.						
Indian Territory	68, 991	44, 154, 240	....	....	....	44, 154, 240
Kansas	81, 318	52, 043, 520	1, 971, 003	635, 419	3, 050, 457	46, 386 641
Nebraska	75, 995	48, 636, 800	647, 031	213, 376	1, 213, 376	46, 563, 017
Dakota Territory	152, 597	97, 662, 080	42, 645	22, 605	237, 126	97, 359, 704
Montana Territory	143, 776	92, 016, 640	84, 674	1, 198	53, 665	91, 877, 103
Wyoming Territory	88, 000	56, 320, 000	338	35	3, 968	56, 315, 659
Utah Territory	88, 056	56, 355, 840	118, 755	215	29, 391	56, 207, 479
Colorado	104, 500	66, 880, 000	95, 594	11, 504	213, 248	66, 559, 654
Arizona Territory	113, 916	72, 906, 240	14, 585	....	7, 222	72, 884, 433
New Mexico Territory	121, 201	77, 568, 640	143, 007	106, 283	584, 259	76, 735, 091
Total	1, 038, 350	664, 544, 000	3, 117, 632	990, 635	5, 392, 712	655, 043, 021
PACIFIC STATES AND TERRITORIES.						
Nevada	112, 090	71, 737, 600	92, 644	13, 415	102, 451	71, 529, 090
California	188, 981	120, 947, 840	6, 218, 133	477, 880	4, 731, 092	109, 520, 735
Oregon	95, 274	60, 975, 360	1, 116, 290	761, 001	511, 961	58, 586, 108
Idaho Territory	86, 294	55, 228, 160	26, 603	7, 476	43, 060	55, 151, 020
Washington Territory	69, 994	44, 796, 160	192, 016	291, 206	165, 917	44, 147, 021
Total	552, 633	353, 685, 120	7, 645, 686	1, 550, 978	5, 554, 481	338, 933, 975
Alaska	577, 390	369, 529, 600	....	....	....	369, 529, 600
General total	3, 607, 211	2, 308, 615, 040	188, 921, 099	159, 310, 179	59, 503, 765	1, 900, 879, 997

From returns in which so large areas are omitted, it would not be profitable to draw conclusions, as any percentages or other calculations

based upon them would still involve much uncertainty. The preceding table, however, affords the only means available for comparing the timber resources of the settled portions of the country.

In taking the census of agriculture, the value of "forest products" realized during the past year from the farm, was entered in a column provided for this purpose in the schedules. It is presumed to generally represent the value of firewood, poles, bark, cooper-stuff, and other wood, &c., sold, but not the amount used on the place. It should be distinct from, and additional to, the "value of lumber products" given in a subsequent table.

6.—*Value of forest products of farms.—Census of* 1870.

States and Territories.	Value.	States and Territories.	Value.
Alabama	$85, 933	Montana	$918
Arizona	....	Nebraska	36, 307
Arkansas	34, 225	Nevada	36, 700
California	566, 017	New Hampshire	1, 743, 944
Colorado	....	New Jersey	352, 704
Connecticut	1, 224, 107	New Mexico	500
Dakota	700	New York	6, 689, 179
Delaware	111, 810	North Carolina	1, 089, 115
District of Columbia	....	Ohio	2, 719, 140
Florida	7, 965	Oregon	259, 220
Georgia	1, 281, 623	Pennsylvania	2, 670, 370
Idaho	....	Rhode Island	254, 683
Illinois	1, 087, 144	South Carolina	167, 253
Indiana	2, 645, 679	Tennessee	335, 317
Iowa	1, 200, 468	Texas	66, 841
Kansas	368, 947	Utah	800
Kentucky	574, 994	Vermont	1, 238, 929
Louisiana	92, 596	Virginia	686, 862
Maine	1, 531, 741	Washington	19, 705
Maryland	613, 209	West Virginia	363, 668
Massachusetts	1, 616, 818	Wisconsin	1, 327, 618
Michigan	2, 559, 682	Wyoming	....
Minnesota	313, 528		
Mississippi	39, 975	Total	$36, 810, 277
Missouri	793, 343		

7.—*Comparative statement of sawed and planed lumber in* 1850, 1860, *and* 1870.

States and Territories.	Value of lumber products.[1]			Establishments.		Steam engines, 1870.		Water wheels, 1870.		Number of saws 1870.
	1850.	1860.	1870.	1860.	1870.	Horse-power.	No.	Horse-power.	No.	
Alabama	$1, 103, 481	$2, 017, 641	$1, 359, 083	339	284	3, 091	110	1, 918	129	381
Arizona	....	....	10, 000	......	1	10	1	......	......	1
Arkansas	122, 918	1, 033, 185	1, 344, 403	178	211	3, 144	123	322	24	245
California	959, 485	4, 214, 596	5, 227, 064	295	291	6, 796	184	3, 009	122	723
Colorado	....	....	324, 370	......	32	494	22	206	11	63
Connecticut	534, 794	531, 651	1, 541, 038	208	393	434	15	6, 905	381	767
Dakota	....	....	72, 280	......	10	248	9	25	2	13
Delaware	236, 863	261, 172	405, 041	71	80	816	32	795	50	131
Dist. of Columbia	29, 000	70, 825	30, 000	1	1	120	1	......	......	2
Florida	391, 034	1, 475, 240	2, 235, 780	87	104	2, 487	69	167	15	219
Georgia	923, 403	2, 064, 026	4, 044, 375	412	532	5, 673	187	4, 786	336	787
Idaho	....	....	56, 850	......	10	83	4	78	6	11
Illinois	1, 324, 484	2, 275, 124	4, 546, 769	463	511	12, 382	455	506	22	777
Indiana	2, 195, 351	3, 169, 843	12, 324, 755	1, 331	1, 861	34, 696	1, 468	5, 303	299	2, 738
Iowa	470, 670	2, 378, 529	5, 794, 285	561	545	12, 758	401	2, 593	121	1, 595
Kansas	....	945, 088	1, 736, 381	124	195	3, 853	154	597	22	279
Kentucky	1, 502. 434	2, 209, 674	3, 662, 086	482	562	9, 443	378	1, 779	101	751
Louisiana	1, 129, 677	1, 018, 554	1, 212, 037	161	152	3, 350	134	33	7	197
Maine	5, 872, 573	6, 784, 981	11, 395, 747	926	1, 099	3, 213	76	38, 898	1, 660	4, 658
Maryland	585, 168	724, 122	1, 501, 471	187	391	2, 373	98	3, 686	273	532
Massachusetts	1, 552, 265	2, 288, 419	3, 556, 870	611	644	2, 019	64	13, 910	697	1, 649
Michigan	2, 464, 329	7, 033, 427	31, 946, 396	986	1, 571	41, 216	1, 137	12, 448	547	7, 052
Minnesota	59. 800	816, 808	4, 299, 162	163	207	4, 539	114	3, 831	119	1, 012
Mississippi	913, 197	2, 055, 396	2, 160, 667	229	265	5, 666	192	419	48	391
Missouri	1, 479, 124	3, 702, 992	6, 363, 112	548	806	14, 697	580	1, 797	87	1, 017
Montana	....	....	430, 957	......	31	165	11	368	20	40
Nebraska	....	316, 104	278, 205	46	50	648	30	358	18	59
Nevada	....	....	432, 500	......	18	290	11	315	9	48
New Hampshire	1, 099, 492	1, 226, 784	4, 286, 142	567	723	1, 928	63	21, 101	996	2, 069
New Jersey	1, 123, 052	1, 602, 319	2, 745, 317	268	285	1, 318	36	4, 655	262	656
New Mexico	20, 000	65, 150	121, 225	9	12	48	2	153	10	15
New York	13, 126, 759	12, 485, 418	21, 238, 228	3, 033	3, 510	20, 042	720	73, 837	3, 600	12, 466
North Carolina	985, 075	1, 073, 968	2, 000, 243	349	523	3, 517	134	4, 535	341	681
Ohio	3, 864, 452	5, 600, 045	10, 235, 180	1, 911	2, 230	36, 728	1, 628	9, 690	580	3, 177
Oregon	1, 355, 500	586, 600	1, 014, 211	126	165	1, 645	40	2, 916	137	264
Pennsylvania	7, 729, 058	11, 311, 149	28, 938, 985	3, 078	3, 739	33, 259	1, 096	55, 553	3, 136	8, 759
Rhode Island	241, 556	172, 174	257, 258	26	81	321	14	1, 168	66	115
South Carolina	1, 108, 880	1, 077, 712	1, 197, 005	361	227	2, 315	82	1, 729	114	375
Tennessee	725, 387	1, 975, 481	3, 390, 687	546	702	7, 357	300	4, 220	291	909
Texas	466, 012	1, 612, 829	1, 960, 851	194	324	4, 710	225	605	31	300
Utah	14, 620	132, 565	661, 431	28	95	285	16	823	75	123
Vermont	618, 065	1, 065, 886	3, 525, 122	415	637	1, 567	37	19, 731	782	1, 552
Virginia	977, 412	2, 537, 130	2, 111, 055	784	605	4, 329	198	6, 038	379	741
Washington	....	1, 172, 520	1, 307, 585	33	46	1, 046	26	733	24	179
West Virginia	....	....	1, 478, 399	......	343	3, 495	144	2, 572	185	453
Wisconsin	1, 218, 516	4, 836, 159	15, 130, 719	520	720	16, 119	377	11, 668	427	4, 127
Wyoming	....	....	268, 000	......	8	151	6	......	......	8
Total	58, 521, 976	95, 912, 286	210, 159, 327	20, 657	25, 832	314, 884	11, 204	326, 781	16, 562	63, 197

[1] This table includes shingles, staves, &c.

Hands employed.

1860. Males, 75,171; females, 691; total, 75,862.

1870. Males above 16—146,047; females above 15—682; youth—3,268; total, 149,997.

Capital, wages, and materials.	1860.	1870.
Capital employed	$143, 493, 232	$74, 530, 090
Wages paid	21, 702, 265	40, 009, 162
Value of materials used	44, 551, 703	103, 343, 430

8.—*Persons employed in manufactories using wood as a material, wholly or in part, or in other employments using forest products.*

Business, or articles manufactured.	Number of persons employed.		
	1850.	1860.	1870.
Agricultural-implement makers	1,313	2,390	25,249
Ax-helve makers		22	
Basket-makers and willow-workers	1,841	2,862	1,779
Bee-hive makers			33
Block-makers		484	
Block and pump makers	1,973		
Block, pump, and spar makers			64
Boat-builders	2,086	2,632	2,381
Bobbin-makers		3	
Box-makers	940	2,634	4,509
Bridge-builders		417	2,090
Dock-builders	270	31	
Builders	1,227	2,911	
Carpenters	184,671	242,958	67,864
Cabinet-makers		29,223	40,554
Chair-makers	37,359		12,462
Cane-makers		4	
Car-builders, &c		477	15,941
Carriage and wagon makers[1]	1,550		55,841
Coach-makers		19,180	
Charcoal-burners	159	203	
Charcoal and coke makers			3,473
Coffin-makers			2,365
Coopers	43,694	43,624	23,314
Frame-makers	143	620	
Hemlock-bark-extract makers			37
Hoop-makers		2	
Kindling-wood makers			701
Last-makers	383	400	510
Lumbermen	10,070	15,929	163,511
Mast-makers		352	
Match-makers	250	418	2,556
Millwrights	9,613	9,063	507
Oar-makers		25	191
Pattern-makers	1,374	5,286	867
Plane-makers	377	261	
Pot and pearl ash makers	164	147	278
Pump-makers		1,541	1,905
Sash and blind makers	2,026		
Sash, door, and blind makers			20,379
Sash-makers		2,309	
Sawyers	11,974	15,000	
Shingle-makers	1,285	2,478	
Ship-carpenters	14,585	13,392	11,063
Shoe-peg makers	49	108	279
Stave-makers	162	262	
Stair-builders		12	
Sumac-grinders			85
Tanners and curriers	14,988	10,481	20,784
Tar-makers		25	
Tar and turpentine makers			2,638
Turpentine-makers	597	1,353	
Turners	3,823	4,027	4,103
Veneering			94
Wheelbarrow-makers			238
Wheelwrights[1]	30,692	32,693	6,989
Wood-corders	206	81	
Wood-cutters	1,322	3,382	
Wood-dealers	473	392	
Wood-pulp makers			111
Woodenware makers		736	3,160
Wooden brackets, scrolls, &c			747
Wood, miscellaneous			715

[1] The terms "wheelwrights" and "carriage and wagon makers" have evidently been confounded in making these returns. Before 1870 only male persons were classified as to employments.

9.—*Comparative product of maple sugar and maple molasses in* 1850, 1860, *and* 1870.

States and Territories.	Maple sugar, pounds.			Maple molasses, gallons.		Percentage of each State to general total, 1870.	
	1850.	1860.	1870.	1860.	1870.	Sugar.	Sirup.
Alabama	643	543			3		
Arizona							
Arkansas	9,330	3,097	1,185	124	75	0.004	0.008
California				6			
Colorado							
Connecticut	50,796	44,259	14,266	2,277	168	0.05	0.02
Dakota							
Delaware							
District of Columbia							
Florida							
Georgia	50	991		20			
Idaho							
Illinois	248,904	131,751	136,873	20,048	10,378	4.68	24.37
Indiana	2,921,192	1,515,594	1,332,332	292,908	227,880	0.51	1.00
Iowa	78,407	248,951	146,490	11,405	9,315	0.003	0.02
Kansas		1,548	938	2	212		
Kentucky	437,405	380,941	269,416	140,076	49,073	0.94	5.27
Louisiana	255						
Maine	93,542	306,742	160,805	32,679	28,470	0.56	3.06
Maryland	47,740	63,281	70,464	2,404	374	0.24	0.04
Massachusetts	795,525	1,006,078	399,800	15,307	2,326	1.40	0.25
Michigan	2,439,794	2,988,018	1,781,855	78,998	23,637	6.26	2.54
Minnesota	2,950	370,947	210,467	23,038	12,722	0.74	1.47
Mississippi		99	125				
Missouri	178,910	142,430	116,980	18,289	16,317	0.41	1.75
Montana							
Nebraska			10	275			
Nevada							
New Hampshire	1,298,863	2,255,012	1,800,704	43,833	16,884	6.33	1.81
New Jersey	2,197	3,455	419	8,088	5	0.001	
New Mexico							
New York	10,357,487	10,816,458	6,692,040	131,843	46,048	23.53	4.95
North Carolina	27,932	30,845	21,257	17,759	418	0.08	0.004
Ohio	4,588,200	3,323,942	3,469,128	370,512	352,612	12.30	38.00
Oregon			11		30		0.004
Pennsylvania	2,326,525	2,768,965	1,545,917	114,310	39,385	5.43	4.23
Rhode Island	28						
South Carolina	200	205	2				
Tennessee	158,557	117,359	134,968	74,372	4,843	0.48	0.52
Texas		69			[1]5,032		
Utah				40			
Vermont	6,349,375	9,819,939	8,894,302	16,253	12,023	31.26	1.30
Virginia	1,227,665	937,643	245,093	99,605	11,400	0.84	1.22
Washington							
West Virginia			490,606		20,218	1.72	2.17
Wisconsin	610,976	1,548,406	507,192	83,118	31,218	1.80	3.25
Wyoming							
Total	34,253,436	38,863,568	28,443,645	1,597,589	921,057	100.00	100.00

[1]Probably not *maple* molasses, and therefore omitted in calculation of percentages.

10.—*General summary of Industries using wood or other forest products as their principal material,* 1870.

Industries.	Number of establishments.	Steam-engines.		Water-wheels.		Hands employed.	
		Horse-power.	Number.	Horse-power.	Number.	All.	Males over 16.
Baskets	127	553	21	220	10	920	755
Blocks and spars	9	78	7	15	1	64	62
Cooperage	4, 961	3, 653	153	2, 644	147	23, 314	22, 764
Hubs, spokes, bows, shafts, wheels and felloes	302	4, 796	189	1, 912	98	3, 721	3, 599
Kindling-wood	70	827	48	30	3	701	523
Lasts	60	465	32	180	10	510	484
Lumber:							
Planed	1, 113	25, 668	848	3, 651	193	13, 640	13, 064
Sawed	25, 817	314, 774	11, 199	326, 728	16, 559	149, 871	145, 926
Staves, shooks, heading	15	110	5	53	3	126	121
Oars	25	238	10	99	5	191	186
Sash, doors, and blinds	1, 605	27, 061	999	7, 758	367	20, 379	19, 496
Shoe-pegs	26	257	10	365	18	279	175
Willow ware	168	25	2	28	2	859	565
Wood brackets, moldings, and scrolls	65	1, 375	54	101	5	747	714
Wooden ware	269	2, 293	76	3, 366	165	3, 169	2, 708
Wood pulp	8	....	....	1, 069	14	111	111
Wood:							
Turned and carved	733	3, 830	221	4, 323	235	4, 103	3, 777
Miscellaneous	117	418	20	727	47	715	673
Bark, ground	33	513	13	169	14	133	131
Hemlock bark, extract	2	140	2	....	....	37	37
Sumac, ground	19	208	10	95	6	85	84
Tar and turpentine	227	177	26	15	1	2, 638	2, 526
Total	35, 771	387, 459	13, 945	353, 558	17, 903	226, 313	218, 481

Industries.	Hands employed.		Capital.	Wages.	Materials.	Products.
	Females over 15.	Youths.				
Baskets	73	92	$376, 945	$224, 878	$158, 109	$594, 739
Blocks and spars	......	2	66, 250	31, 914	28, 565	95, 095
Cooperage	20	530	9, 798, 847	7, 819, 813	12, 831, 796	26, 863, 734
Hubs, spokes, bows, shafts, wheels and felloes	5	117	4, 050, 609	1, 544, 896	2, 204, 713	5, 285, 157
Kindling-wood	2	176	562, 750	253, 150	486, 642	930, 294
Lasts	2	24	330, 800	262, 212	137, 657	665, 703
Lumber:						
Planed	52	524	18, 007, 041	6, 222, 076	28, 728, 348	42, 179, 702
Sawed	682	3, 263	143, 399, 082	39, 966, 817	103, 102, 393	209, 852, 527
Staves, shooks, heading	......	5	94, 150	42, 345	241, 037	306, 800
Oars	3	2	158, 798	61, 210	45, 845	178, 139
Sash, doors, and blinds	43	840	21, 239, 809	10, 059, 812	17, 581, 814	36, 625, 806
Shoe-pegs	98	6	169, 900	78, 051	63, 736	264, 847
Willow ware	68	226	208, 755	171, 213	143, 634	510, 930
Wood brackets, moldings, and scrolls	3	30	832, 275	734, 640	636, 423	1, 472, 042
Wooden ware	67	394	2, 814, 592	1, 210, 268	1, 623, 694	4, 142, 124
Wood pulp	......	......	191, 000	60, 178	29, 500	172, 350
Wood:						
Turned and carved	103	223	2, 751, 549	1, 499, 565	1, 648, 008	4, 959, 191
Miscellaneous	11	31	481, 495	257, 451	388, 549	1, 018, 047
Bark, ground	......	2	322, 760	47, 069	194, 491	372, 829
Hemlock bark, extract	......	......	85, 000	19, 500	32, 630	185, 300
Sumac, ground	1	......	167, 450	31, 325	164, 702	267, 180
Tar and turpentine	81	31	902, 225	476, 284	2, 146, 090	3, 585, 225
Total	1, 314	6, 518	207, 012, 082	71, 074, 667	172, 618, 376	340, 527, 761

11.—*General summary of Industries using wood as a part of their material*, 1870.

Industries.	Number of establishments.	Steam-engines.		Water-power.		Hands employed.	
		Horse-power.	Number.	Horse-power.	Number.	All.	Males over 16.
Agricultural implements	2, 076	15, 873	676	10, 209	426	25, 249	24, 634
Bee-hives	15	11	2	31	3	33	32
Boats	174	1, 446	45	13	2	2, 381	2, 350
Boxes, cheese	194	547	40	2, 318	136	694	662
Boxes, packing	489	4, 303	195	2, 642	148	4, 509	4, 084
Bridge-building	64	1, 034	36	40	2	2, 090	2, 069
Carpentry and building	17, 142	4, 654	289	1, 140	73	67, 864	67, 306
Carriages and sleds, children's	53	366	22	391	21	913	780
Carriages and wagons	11, 847	4, 169	279	4, 651	363	54, 928	54, 280
Cars, railroad	170	5, 609	134	163	4	15, 931	15, 690
Clock-cases	5	4	2	63	4	68	65
Coffins	642	359	19	183	13	2, 365	2, 292
Furniture, not specified	5, 423	14, 811	764	6, 920	406	40, 554	38, 023
Furniture, chairs	529	3, 203	117	4, 740	184	12, 462	6, 975
Furniture, refrigerators	27	114	6	24	2	267	260
Looking-glass and picture frames	320	1, 017	49	93	4	3, 587	2, 976
Patterns and models	165	398	58	25	5	867	705
Ship-building	762	3, 311	119	109	6	11, 063	10, 978
Veneering	10	324	6	45	2	94	74
Wheelbarrows	23	213	10	297	15	238	204
Wheelwrights	3, 613	554	32	983	75	6, 989	6, 915
Total	43, 743	62, 220	2, 900	35, 080	1, 894	253, 146	241, 354

Industries.	Hands employed.		Capital.	Wages.	Materials.	Products.
	Females over 15.	Youths.				
Agricultural implements	12	603	$34, 834, 600	$12, 151, 504	$21, 473, 925	$52, 066. 875
Bee-hives	....	1	15, 350	3, 172	8, 459	21, 452
Boats	1	30	1, 665, 193	1, 225, 096	1, 214, 016	3, 300, 775
Boxes, cheese	11	21	424, 375	125, 012	242, 937	570, 840
Boxes, packing	195	230	3, 571, 942	1, 909, 088	4, 236, 745	8, 222, 433
Bridge-building	....	21	2, 973, 250	1, 123, 353	3, 239, 771	5, 476, 175
Carpentry and building	5	553	25, 110, 428	29, 169, 588	65, 943, 115	132, 901, 432
Carriages and sleds, children's	89	44	746, 628	407, 327	495, 281	1, 432, 833
Carriages and wagons	76	572	36, 563, 095	21, 272, 730	22, 787, 341	65, 362, 837
Cars, railroad	20	221	16, 632, 792	9, 659, 992	18, 117, 707	31, 070, 734
Clock-cases	1	2	53 700	27, 784	71, 479	111, 430
Coffins	42	31	2, 592, 862	1, 011, 397	1, 412, 078	4, 026, 989
Furniture, not specified	657	1, 874	35, 740, 029	17, 901, 379	21, 660, 837	57, 926, 547
Furniture, chairs	3, 168	2, 319	7, 643, 884	3, 522, 940	3, 979, 743	10, 567, 104
Furniture, refrigerators	....	7	548, 000	141, 212	192, 409	506, 463
Looking-glass and picture frames	196	415	2, 590, 020	1, 623, 653	2, 466, 313	5, 962, 235
Patterns and models	132	30	634, 715	408, 248	235, 933	1, 211, 191
Ship-building	2	83	9, 102, 335	5, 594, 686	8, 252, 394	17, 910, 328
Veneering	20	....	229, 550	45, 310	129, 918	241, 750
Wheelbarrows	8	26	243, 750	111, 390	106, 420	472, 720
Wheelwrights	11	63	2, 839, 316	1, 353, 474	1, 907, 418	5, 846, 943
Total	4, 646	7, 146	184, 755, 814	108, 788, 335	178, 234, 239	405, 210, 086

TIMBER RESOURCES OF SEVERAL OF THE STATES.

In the absence of official sources of information through the agencies of the general government, aside from the census statistics already given, we have prepared, from various sources as credited, the following information concerning the production of lumber, and to some

extent the amount of our resources in forest products. In reference to the statistics of the census, they do not pretend to give areas except as occupied for farming purposes, and in the general aggregate they leave nearly two billions of acres not accounted for. The percentages given in the preceding tables show the risk we run in taking them as representing absolute quantities.

The sources of our information, in the following statements, it will be seen, include facts reported in geological and other surveys and explorations, geographical and historical accounts, correspondence, and statistics obtained through the agency of State governments, or the enterprise of those conducting business journals.

Early in the course of these inquiries, circulars, with specific inquiries, were addressed, asking for information within the line of their own observation, and embracing in business matters the results of their own experience, as follows:

1. To nurserymen and others engaged in raising and planting trees.
2. To tanners, and manufacturers of tanning extract.
3. To superintendents of railroads, and others engaged in constructing or supplying such roads.
4. To owners and managers of furnaces, forges, and other establishments using charcoal as fuel.
5. To botanists, entomologists, and other observers in natural history.

A special blank for returning lists of native and introduced forest-trees, their relative abundance and size, with notices of the results of experiments in the introduction of new species, and such facts of economical or scientific interests as might be known by those reporting.

Several thousands of these circulars were sent out, and large numbers were returned, carefully filled up by correspondents, and, for the most part, evidently with scrupulous care and fidelity. Some of these facts have been already presented, but, so far as they relate to the geographical range of species and other matters of most value when carefully classified and generalized, they are too incomplete for present use. Many of these facts, such as limits of greatest abundance, and of possible growth, can best be shown upon maps, and other facts by tabular representation. These data, and those embraced in returns from a circular previously issued by the Department of Agriculture,[1] will be made available to science, in such manner as may hereafter appear most effectual.

---

[1] In the spring of 1876 a circular of a somewhat general character was addressed to the correspondents of the Department, and about 1,100 were returned. Attention was called, in this, to the kind and quantity of timber, cord-wood, or other material yielded by forests per acre, either as averages for the country, or as specified areas of the best-wooded forests. It called for immediate return, and time was therefore not allowed for inquiry. The replies were accordingly, for the most part, individual estimates, but a large number bore evidence of careful preparation and extensive knowledge upon the subjects reported. These returns were used, in part, in the preparation of an article upon forestry, published in the Report of the Department of Agriculture for 1875 (pp. 244 to 358), in connection with census data, and facts from other sources.

A considerable amount of information which they afforded was not published in the abstract referred to, but the entire series has been carefully examined by us, and every fact which the returns afford has been noted for such further use as may be found practicable. Ample correspondence has been had in reference to uncertain points, and through these several agencies of inquiry a very extended list has been prepared of the names of those known to take an interest in forestry, and who are both able and willing to co-operate in contributing facts and experience for its advancement.

In the present report the data returned upon the circulars last referred to have not been used, as other materials deemed of interest appeared to claim precedence, and a limit had been placed upon the extent of the volume.

These unpublished data chiefly tend to show by estimate the character and extent of our timber and lumber resources, and the industries depending upon the production and use of forest products, the profits that may be realized from their cultivation, or

In preparing the following statements, we have studiously avoided giving credit to any representations that appeared intended to unduly enhance or depreciate the value of timber-lands or forest-products, or to promote, in any way, a private interest. But believing that a realization of the direct and incidental benefits to be derived from a due proportion of woodlands of the country would lead to greater care in their maintenance, and to measures tending to prevent waste, we have endeavored to show that this belief is sustained by facts, and therefore worthy of general acceptance.

The inconveniences and physical evils attending a destitution of woodland can largely be prevented by appropriating a certain proportion of each farm to the growth of forest-trees. There is reason to believe, that if one-fifth of each farm on the prairies were given to this culture, the remainder would more than yield what is now realized from the whole, on account of the favoring conditions of climate which the presence of scattered woodlands would induce.

It will be noticed that of some States no information is given in the following pages, and of others but a few statistics of particular industries or other facts of a local nature. Numerous data have been collected concerning lumber-markets and the timber-trade, the inland and coastwise transportation of forest products, laws and usages of inspection, range of prices and influences that have affected them, and other information of a practical kind, which, however, still leave too many points to be supplied, and must for this reason be omitted from the present report.

MAINE.

The commercial and ship-building interests of this State are presented in the statistical part of this report.[1] The former are but partially represented in the general tables of exportation, because, under the treaty of Washington, citizens of the State are allowed to export their products by way of the Saint John and Saint Croix Rivers.

The Saint John district of Maine, being the part north of a line run from Grand Falls to a point between Baker Lake and Boundary Branch, forms quite a distinct botanical district, which, in the state of nature, bore a thick growth of the evergreen trees, generally of good size and valuable for timber. South of this we find a prevalence of the hard woods, such as maples, beeches, oaks, and amentaceous forms of forest growth.

Mr. Calvin Chamberlain, of Foxcroft, Me., in a lecture delivered in 1868, in speaking of the effect of clearing forests in Maine, remarks:

I designed to speak of the already destitute condition of some neighborhoods on the coast-line of our State, in regard to timber and fuel, where all the farmers in the

---

the preservation of timber-lands, the injuries resulting from fires, insect ravages, disease, waste, and other causes, and the economical value of forests, and forests generally, as well in regard to the benefits they may bring to their owners as to the public generally. Although, for the most part, nothing but estimates, they were generally from persons well known in the communities in which they live, and not a few are widely and favorably known. They are persons who have no theories to defend, with respect to the unsettled points involved in the forest-question, and no motives for statements beyond the plain results of their own observation and local knowledge.

[1] The allusions to statistics of ship-building, and the exportation of forest products, refer to a portion of this report of sufficient extent for a separate volume, embracing these data from the organization of the government in 1789 down to the present time, with ample generalizations, calculations of percentages and prices, and graphic illustrations. This part had not been ordered for printing at the time of publication of this volume.

present generation were cutting off their wood for the Boston market. All have now reached their last tree, and are bringing wood for their own fires from distant points on the coast. Now these same farms have nearly ceased to produce aught for man or beast, and domestic animals have nearly been banished from them.

This impairment of values is by no means local in extent, nor limited to agricultural interests alone. Its effect may be especially seen in the ship-building interests of that State, which, although still carried on to a large extent, must now depend for its principal supplies upon a distant timber-market. The circumstance that gave the first impulse to this business was the abundance and excellence of the timber, which gave to Maine the familiar designation of the "Pine-tree State," and suggested a pine tree as the central figure of the State seal.

The following data concerning the lumber production of Maine are derived in part from an article in the *Kennebec Journal* (Augusta), of December 26, 1877:

On the Kennebec River.—The average production for several years has been about 125,000,000 feet. In the winter of 1877 the cut of logs was reduced to about 60,000,000, and this reduction was forced upon the lumbermen by the continued depression of business. The arrangements for the winter of 1878 were for 50,000,000, but the lateness of snowfall makes it probable that it may prove even less.[1] The production was 76,000,000 in 1867, and 113,000,000 in 1876. At the present time there are very few old logs manufactured on the river. Usually, the lumbermen carry over logs enough to supply the mills until the opening of navigation (about the 1st of May), when the new logs come down; so that few of the mills will next season be able to start up before the 1st or middle of June. To secure the cut for the winter, some 1,200 men had gone into the woods with about 250 teams.

On the Penobscot River.—The number of feet of lumber manufactured at Bangor and vicinity during the last twenty-two years, as shown by the official records, has been as follows:

Years.	Green pine.	Dry pine.	Spruce.	Hemlock.	Total.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*
1856	85, 411, 378	17, 000, 089	66, 526, 983	11, 323, 386	180, 262, 230
1857	60, 875, 020	14, 941, 023	56, 725, 284	12, 557, 680	145, 109, 000
1858	16, 230, 129	13, 223, 715	62, 045, 696	16, 166, 907	147, 666, 447
1859	73, 054, 637	10, 424, 752	77, 432, 074	15, 275, 553	176, 187, 016
1860	87, 386, 610	10, 314, 565	88, 027, 510	14, 662, 811	200, 391, 526
1861	29, 402, 742	8, 616, 185	72, 626, 900	9, 874, 824	130, 529, 651
1862	49, 288, 178	11, 732, 569	90, 135, 783	7, 421, 392	158, 577, 922
1863	49, 788, 162	12, 806, 074	108, 904, 447	16, 622, 364	188, 122, 047
1864	43, 289, 179	11, 557, 327	106, 774, 936	12, 814, 830	174, 436, 272
1865	35, 137, 683	13, 158, 539	107, 505, 867	14, 078, 934	169, 881, 023
1866	50, 903, 269	12, 671, 142	154, 571, 243	19, 005, 952	237, 147, 606
1867	40, 429, 849	10, 777, 325	139, 445, 478	15, 830, 706	206, 483, 358
1868	41, 202, 167	9, 107, 232	152, 931, 455	17, 553, 912	220, 794, 766
1869	30, 796, 811	10, 184, 100	133, 756, 759	16, 103, 240	190, 840, 908
1870	22, 999, 000	7, 030, 000	149, 103, 192	22, 881, 000	202, 014, 192
1871	35, 613, 000	6, 770, 000	163, 121, 675	21, 987, 000	229, 491, 675
1872	37, 570, 000	8, 580, 000	176, 933, 649	23, 370, 000	246, 453, 949
1873	25, 553, 985	7, 032, 863	129, 277, 908	17, 337, 597	179, 202, 353
1874	18, 509, 448	5, 663, 861	135, 226, 015	17, 382, 608	170, 786, 932
1875	17, 049, 884	5, 285, 965	116, 664, 487	15, 662, 793	154, 663, 129
1876	15, 001, 624	4, 613, 948	82, 087, 987	13, 417, 632	115, 121, 191
1877	10, 655, 443	4, 048, 709	85, 480, 149	17, 683, 444	117, 867, 745

[1] This anticipation of an open winter was more than realized, and at the time of writing this note (May 1, 1878) accounts from lumber regions throughout the Northern States agree in representing the amount of logging done, as everywhere much below the average of common winters. As most of the lumber sawed during the summer comes down with the spring floods, the production for the current year must necessarily be relatively small.

The estimated cut for 1878 was 100,000,000. About 18,000,000 of this lumber is shipped to European markets in "deals," mostly sawed from spruce, 3 by 7, 3 by 9, and 3 by 11 inches. The price of spruce logs at the mills was $12 per M feet in 1867, and $9 in 1877. The price of spruce manufactured in 1867 was $13 for random and $15 for dimension pieces. In 1877 it was $10 for the former and $11 for the latter. It is estimated that the shingles and other short lumber sold in that market will be about one-quarter of the value of the long or sawed lumber.

On the Passamaquoddy River.—It was estimated that double the amount of logs would be handled on this river and its tributaries in the winter of 1878 than the season before. Some 150 men had gone into the woods with 80 horses and 20 oxen. Spruce logs are worth $8 per M, and men's wages from $13 to $17 per month.

On the Saint Croix River.—Quite a number of firms have gone out of the business since 1867. "If the winter of 1878 should prove a fair one a third more of logs would be got out than in the last season." Not 10 per cent. of the lumber goes to foreign ports generally. The amount sawed in 1876 was 63,000,000, and in 1877 60,000,000 of feet. On both branches of the Saint Croix 1,700 men and 850 oxen and horses were employed. About 65,000,000 feet were expected to be cut the winter of 1877. Prevailing prices of lumber: Spruce, $10 to $13; hemlock, $7 to $8; pine, $10 to $12; hard-wood ship-plank and timber, $15 to $20, delivered at the vessel in Calais. "The stock of longs is almost entirely sawed up during the late season, and the quantity manufactured will not vary much from that of 1876, there being quite a stock of old logs on hand at that time. Lumber is being got at lower rates than usual the present season, but wages being low a fair margin is allowed for profit."

On the Saint John River.—The lumber business on this river was expected to be double that of the last. It was estimated that there would be driven into the Saint John market in 1878 more than 200,000,000 feet. On the Upper Saint John, above Van Buren, there would be employed 700 men and 200 horses. The wages were $15 per month for men, and $28 for men and horses. Whole number of men estimated at 4,500, and number of teams 1,200. Average stumpage, $1.75 per M feet.

On the Saco River.—The amount of lumber manufactured on this river was 33,000,000 feet in 1874, 24,000,000 in 1875, and 20,000,000 in 1876. It is estimated that the cut in the winter of 1877–'78 would be 18 000,000. These amounts do not include the quantities produced by the Bartlet Land and Lumber Company, at the head of the Saco River, which amount to a little over 4,000,000 a year, and send by railroad to Portland. No small lumber is manufactured on the river, pine, spruce, and hemlock being the kinds used. About 2,000,000 of sapling shingles are made annually.

On the Narragaugus River.—The business was expected to increase from that of last year about one half. Number of men employed the present winter (1877–'78), 200; horses, 76; oxen, 80. Average wages paid to men, $22 per month; amount of anticipated cut, 13,000,000 feet. There are manufactured annually about 12,000,000 feet of long lumber, 8,000,000 laths, 5,000,000 shingles, and 200,000 clapboards. Prices: Pine shipping boards, $15 per M; pine refuse boards, $10; spruce boards, $10; laths, $1.15 per M.

On the Union River.—During the past season, the production on this river amounted to 24,000,000 of long lumber, 14,000,000 of shingles, 4,000,000 of lath, 10,500,000 of staves, 100,000 clapboards, 500 tons of "excelsior," and 100,000 feet of spool-wood. This is exclusive of fuel, railroad ties, hemlock-bark, &c. This amount will fall short of last

year's product by one-third, and would exceed that of the coming season by one-fourth.

On the Androscoggin River.—On this river there has usually been cut, above Bethel, for the last ten years, 5,000,000 feet annually. The present season it was estimated would produce 25,000,000 to 30,000,000. This has reference to the lumber cut for the market, not including that for home consumption.

On the Sandy River.—But very little lumber has been cut from 1867 to the present time, with the exception of one year (some five years ago), when about 1,200,000 were cut.

Transported by the Maine Central Railroad.—The number of car-loads of lumber transported by this road was as follows, in the last two years:

1876, 2,987 cars of "long" and 1,962 cars of "short" lumber.

1877, 2,393 cars of "long" and 1,814 cars of "short" lumber.

With respect to the prospects for 1878, the *Kennebec Journal*, of December 26, 1877, says:

"On a review of the entire field, there will, perhaps, be more lumber cut the present than the past year, and unless something unusual occurs, the low prices will prevail the next year. There has been a large number of failures during the year among lumbermen, affecting some of the largest corporations. The most of them, however, have effected a settlement, and are doing business again, their creditors having generally manifested a liberal disposition. The failures generally have not been because of bad management, extravagance, or fraud, but on account of continued depression in business and the failures of large purchasers."

CUMBERLAND COUNTY.—The principal native trees of this section in the order of greatest abundance are pine, oak, maple, birch, beech, poplar, ash, and bass. The most valuable is the pine; the most valued for fuel, beech and maple. Where pine is cut off the next growth is birch, beech, and maple, with an occasional hornbeam.—*A. P. Reed, South Bridgeton, Me.*

NEW HAMPSHIRE.

A chapter on the distribution of plants in New Hampshire, by William F. Flint, published in the geological survey of this State,[1] gives some account of the forest trees and their distribution, from which we condense the following notes:

The whole State was originally covered with a dense forest growth, the principal kinds of timber being pines, spruces, oaks, and hickories, beech, chestnut, white, red, and sugar maples, butternut, birches, elm, white and black ashes, basswood, and poplars. A striking contrast is shown in the aspect of the northern and southern portions of the State, caused by differences of temperature due to altitude, the transition being gradual, some species becoming scarce, and finally disappearing, while others first appearing in small numbers increase as we go north or south until they may become the prevailing kinds. A few species occur throughout the entire State. A line drawn from North Conway to Lake Winnipiseogee, and from thence to Hanover, would somewhat distinctly divide the northern from the more southern types. This transition area would be at an elevation of about 600 feet above tide, corresponding with the annual mean of 45°, or of 20° in winter and 65° in the summer months.

[1] *Geology of New Hampshire*, 1874, vol. 1, p. 381; accompanied by a colored map, showing the distribution of forest trees.

Among the species characteristic of the more southern type which here find their northern limit may be mentioned the chestnut, white oak, spoon-wood or mountain laurel, and frost-grape. The range of pines and walnuts, of white or river maple, red oak and hemlock, is also mainly southern. The more characteristic trees of the northern class are the sugar-maple, beech, balsam-fir, black and white spruce, and arbor-vitæ, and of smaller trees the mountain ash and striped maple. Of these the white spruce and arbor-vitæ have the most limited range. The former is abundant about Connecticut Lake, but occurs rarely, if at all, south of Colebrook. The latter (*Thuja occidentalis*), is also common in this section, extending south to the vicinity of the White Mountains, and is also occasionally found in highland swamps farther south.

The pine family forms the most important feature of the landscape, and has been an important source of wealth to the State. The white pine originally filled all the river valleys with a heavy growth, extending along that of the Connecticut to the northern boundary. This growth has now nearly disappeared before the lumberman's ax, but the great abundance of saplings in the southern part of the State shows that this species is still the principal conifer of that section. Passing northward into Coos County, we find the white pine much restricted in area, occurring mostly at the headwaters of the streams, and mainly confined to the first-growth specimens, saplings being of rare occurrence, even where the land is allowed to return to forest after clearing.

The pitch and red pines are of more limited range, the former (*P. rigida*) occurring most along the sandy plains and drift knolls of the river valleys, scarcely growing on hills that attain much elevation above the sea level. It is found most abundantly in the southeastern part of the State, and in the Merrimack Valley and around Lakes Winnipiseogee and Ossipee, extending northward as far as North Conway. In the Connecticut Valley it appears less abundantly. The red pine (*P. resinosa*), often called "Norway pine," "is the most social of the pine genus," occurring in groups of from a few individuals to groves containing several acres. Although much less common, its range is about the same as that of the pitch-pine, probably attaining a higher elevation above the sea level. This species is of handsome and rapid growth, and is well worthy of being planted for ornament.

In the White Mountain region the balsam-fir and black spruce, growing together in about equal numbers, giving to the scenery one of its peculiar features. They are the last of arborescent vegetation to yield to the increased cold and fierce winds of the higher summits. North of these mountains, the arbor-vitæ forms the predominant evergreen, mingled with the white spruce about Connecticut Lake. In the southern part they are mostly confined to the highlands between the Merrimack and Connecticut Rivers, the black spruce being most abundant.

The hemlock is common in the southern part of the State, ranging most abundantly around the base of the Rocky Mountains, southward along the highlands, becoming less near the coast. Its northern limit is in the vicinity of Colebrook and Umbagog Lake, reaching an elevation of 1,200 feet above tide.

The tamarack does not enter largely into the flora of New Hampshire, being chiefly found in swamps of small extent, and ranges along the highlands from Massachusetts to north of the White Mountains. The red cedar is chiefly limited to the sea-shore. The juniper is sometimes troublesome by overspreading hilly pastures. The American yew is often present in cold-land swamps.

The maples are best represented among deciduous trees. The river

maple is most limited in range, being confined to intervals of the principal streams, and rarely far away from them. The red maple is common in all parts of the State, and the sugar-maple is abundant, filling an important part in the economy of the State, supplying both timber and sugar. It is common in most parts, but less toward the sea-coast. This with the beech makes up the greater part of the hard woods of Coos County. Southward the beech is common on high lands only, often growing with spruce and hemlock.

Four species of birch are common, of which the black, yellow, and canoe birches have about the same range as the red maple. The canoe or paper birch grows high up the sides of mountains. The fourth and smallest, the white birch, is most abundant in the southeast part of the State, affording the "gray-birch hoop-poles" used in the manufacture of fish-barrels.

Five or six species of oaks are found, of which the hardiest is the red oak. Although the only species found along the water-shed between the Merrimack and Connecticut, it does not extend much beyond the White Mountains, having its upper limit at about 1,000 feet above the sea. The white and yellow oaks usually appear together, on the plains and hillsides along the rivers. The former extends northward in the Connecticut Valley nearly to the mouth of the Passumpsic, in the Merrimack Valley to Plymouth, and in the eastern part of the State to the vicinity of Ossipee Lake. Its limit in altitude is about 500 feet above the sea, which is also very nearly that of the frost-grape. The barren or shrub oak is abundant on the pine plains of the Lower Merrimack Valley, thence extending eastward to the coast, and to the sandy plains of Madison and Conway. The chestnut oak seems to be local in this State; at Amherst and West Ossipee it can be found abundantly.

The chestnut is found in the same situations as the white oak, but is first to reach its limit of altitude, which is about 400 feet above the sea. It occurs in a few localities about Lake Winnipiseogee at a somewhat greater height, the neighborhood of the lake producing less severity of temperature than in the river valleys at the same altitude.

The American elm attains probably the largest size of any deciduous trees. It grows best in alluvial soil, and is the most extensively planted for shade and ornament of all trees, unless, perhaps, the sugar-maple.

Butternuts also prefer the borders of streams and, in the valley of the Pemegewasset extends northward to the base of the mountains. Hickories are most common in the Lower Merrimack Valley, the shell-bark extending northward to the vicinity of Lake Winnipiseogee. Basswood is found mostly on the highlands, but is not very common. The black cherry is found throughout the State, usually most common near streams. Two species of poplar are common; the first a small tree, very common in light soil, and often springing in great abundance where woodland is cleared away. The other, the black poplar, may be a large tree.

The Hon. Levi Bartlett, of New Hampshire, has given in the result of his experience, an interesting illustration of the profits that might be realized from tree-planting in this State, covering a period of about fifty years. A tract had been cleared and thoroughly burned over in a very dry season, about the year 1800. It immediately seeded itself with white and Norway pines, and about twenty-five years after, came into his possession. He at once thinned out the growth on about two acres, taking over half the number of the smallest trees, the fuel much more than paying the expense of clearing off. From that time, nothing was

done with the lot for the next twenty-five years—having sold it, however, during that time. Upon examining it he found that, by a careful estimate, the lot which had been thinned was worth at least a third more per acre than the rest which had been left. It was worth at that time at least $100 an acre. He thought that had the land been judiciously thinned yearly, enough would have been obtained to have paid the taxes and interest on the purchase, above the cost of cutting and drawing out, besides bringing the whole tract up to the value of the two acres which had been thinned out.

At the time when this part was thinned, (twenty-five years from the seed) he took a few of the tallest, about 8 inches on the stump, and 40 to 50 feet high, and hewed on one side for rafters for a shed. At the next twenty-five years, (fifty from the seed), he and the owner estimated that the trees left on the two acres would average six or eight feet apart. They were mostly Norway pine, ten to twenty inches in diameter, and eighty to a hundred feet high. He was greatly surprised seven or eight years after, to see the increase of growth, especially the two acres thinned thirty years before. The owner had done nothing, except occasionally cutting a few dead trees. It was now the opinion of both, that the portion thinned out was worth twice as much as the other; not, however, that there was twice the amount of wood on the thinned portion, but from the extra size and length of the trees, and their enhanced value for boards, logs, and timber. There were hundreds of Norway and white pines that could be hewn or sawed into square timber, from 40 to 50 feet in length, suitable for the frames of large houses, barns, and other buildings. There were some dead trees on the two acres thinned at an early day, but they were only small trees shaded out by the large ones. On the part left to nature's thinning, there was a vastly greater number of dead trees—many of them fallen, and nearly worthless. Of the dead trees standing, cords might be cut, well dried, and excellent for fuel. Estimates were made that this woodland would yield 350 cords of wood, or 150,000 feet of lumber per acre. Allowing that these were too large, the real amount must have brought a very large profit on the investment.

It is estimated by Mr. Joseph B. Walker,[1] that about 3,000,000 of acres, or half the area of New Hampshire, is wooded—some with primitive, but much of it with recent, growth, scattered over all parts of the State, in tracts varying from a few acres to a few thousand.

It is interesting to notice traces of regulations tending to the preservation of forests in this region in the earliest periods of settlement, evidently by those who had witnessed the worth of timber, or who had felt its want. In 1640, only two years after settlement, the inhabitants of Exeter, regulated the cutting of oak timber by a general order, and in 1708, the Provincial Assembly forbade the cutting of mast-trees on ungranted lands, under a penalty of £100 sterling. The province at that period had a surveyor-general of forests, for preventing depredations upon timber.

Carroll County.—Poplar timber is in fair demand, and is manufactured into excellent shingles, boards, &c., though to lay on the roofs of houses, they are inclined to warp. (*J. L. Hersey*, Carroll County, N. H.)

Cheshire County.—The area of woodland in this county is constantly increasing, a state of things which speaks well for the future, as the people are becoming aware that the farms high up among the hills.

[1] *Address upon the forests of New Hampshire.* Delivered under the auspices of the Board of Agriculture during the winter of 1871–'72. 8vo., pp. 20.

are of more value when devoted to wood than to cultivation. Without doubt, the inhabitants of Southern New Hampshire derive more wealth from their forests than from the cultivation of the soil, and if proper measures were taken to prevent waste, and to care for the forests, it could not fail to increase the prosperity of the people far more than it has yet done. (*William T. Flint*, Winchester, N. H.)

COOS COUNTY.—The New Hampshire Board of Agriculture, at a session held at Whitefield in December, 1873, visited a lumber-camp in this county, the report of which has facts of interest in forestry.

Attention was called to a white pine over 4 feet in diameter, and 200 feet or more high, said to be worth over $1,000 on the stump. Many trees were worth from $100 to $500 each. The growth was principally hemlock, pine, and spruce, and would yield in some instances 150,000 feet or more per acre. The average cost when purchased, was $11 The company whose works they visited, owned 30,000 acres, mostly still covered with forest, and had built some dozen miles of railroad into the heart of the woods, using the ordinary T-rail. (*Fourth Report, N. H. Board of Agriculture*, p. 54.)

VERMONT.

This State, which derived its name from the somber evergreen forests which covered its mountains when first explored by Europeans, has lost most of its importance as a lumber-producing State, although the manufacture of wooden articles still forms an important feature in its industries at many places. Most of the hewn timber which this State has produced found a foreign market by way of Quebec, and the greater part of its sawed lumber, was sent to American markets by way of the Champlain Canal.

The following facts concerning the woodlands of Washington County, an interior county somewhat north of the central part, are furnished by a correspondent:

Mad River is the largest tributary to the Winooski, and drains a narrow valley between ridges of the Green Mountains, with good farms along the intervales, and on higher lands. Trees on the mountains, spruce and hemlock; lower down, deciduous kinds. Cedar is entirely wanting, and oak is rare. Sugar-maple is the most commonly planted for ornament; next the elm, tamarack, and pine. Fruit-trees do well on ground somewhat elevated, but only the hardiest kinds withstand the winters in the valleys. The chestnut has been introduced, and does well on some hill-sides, as also the locust in most places. The Baldwin apple fails. No planting for timber has been done yet, but the growth of young trees is, in some cases, encouraged, especially the sugar-maple, of which farmers can now tap twice the number they could twenty years ago. In some cases sugar-orchards are fenced from cattle, and are soon filled with a dense growth of young trees. I have a few acres, from which most of the timber, except maples, was cut, and the land fenced, but have succeeded better in starting white ash than maples. Since clearing, the springs and streams fail, and larger, deep streams become variable. An early settler tells of our river once having long reaches of still water, abounding in trout and other fish. These places were caused by obstructions, over which the water poured in a cataract. They are now gone; the stream is shallow, so that "a man could almost drive a horse and wagon, the whole length, in low water." The deep places are filled with gravel from the hills, and this is true of all the lateral streams, which are alternately dry beds and torrents. A storm will now raise the streams much quicker than formerly, and the floods subside as quickly. No evidences appear to show less annual rain-fall, but the streams and fields dry up sooner. No less snow falls, but it seldom accumulates as formerly, and our winter thaws and south winds carry it off very rapidly in many places where formerly sheltered by woodland.

As to tendency to change of species, the spruce or hemlock will often come up in place of hard-wood, and *vice versa*. A considerable amount of lumber, chiefly spruce, is got out yearly, the butt logs of best trees being sawed into clapboards, or split into staves or shingles, and the rest sawed into board for market. Hemlock is extensively cut for bark and coarse lumber for local use, it being too cheap to pay transportation. Basswood comes next to spruce in value. White ash, birch, maple, &c., are cut. Some manufactories of wooden bowls, chair-stock, clothes-pins, eave-spouts, &c., exist. (*E. A. Fisk*, Waitsfield, Vt.)

MASSACHUSETTS.

This State was the first in the Union to order a special survey of its forest resources. Having previously caused a geological exploration, it in 1837 made provision for a zoological and botanical survey, and in organizing this commission Governor Everett selected Mr. George B. Emerson, of Boston, a well-known educator, and in every way fully qualified for the task, to prepare a report on the trees and shrubs of the State, keeping in view the economical relations of the inquiry, and having for a principal object to promote the agricultural benefit of the commonwealth, by leading the owners of land to a consideration of the importance of continuing, improving, and enlarging the forests of the State.

The report of Mr. Emerson was published in 1846, as a State document,[1] and a second and finely-illustrated edition was issued by the author's publishers on private account in 1875.[2] To collect information for this report, its author explored from time the forests in almost every part of the State, from the western hills of Berkshire to Martha's Vineyard, and from the banks of the Merrimack to the shores of Buzzard's and Narragansett Bays, and by means of circulars, correspondence, and personal inquiry, sought every opportunity for gaining full and reliable information upon every point that came within his field of research.

The discussions in agricultural societies, and by the public journals in this State upon the subject of forest culture, and the various economies relating to forest products, date further back and contain more materials than those of any other State in the Union; and although there are perhaps no forests managed with strict attention to the rules laid down by scientific foresters of Europe, there are numerous tracts of woodland kept for periodical cutting as coppices. A considerable amount of planting is done every year for forest growth, especially in the eastern part, and in the way of ornamental planting in villages, as fine examples can probably be seen in this State, as anywhere in the world.

Yet the State of Massachusetts has been for a long time an importer of wood, and for more than fifty years, a large proportion of the materials used in house and ship building, have been brought from other States. Mr. Emerson in his first report mentions certain manufactures of wood, such as furniture, carriages, planes, lasts, bowls, agricultural implements, &c., that were already dependent for supplies upon Maine, New York, and the Southern States, and at the present time these sources are in a large degree removed still farther away, the largest amount coming from the Western States, Canada, and New Brunswick.

The native resources of this State in trees are ample in variety, and

---

[1] *A report on the Trees and Shrubs growing naturally in Massachusetts, published agreeably to an order of the Legislature by the Commissioners on the Zoological and Botanical Survey of the State.* Boston, 1846. pp. xv., 535, with 16 outline plates of blossoms, leaves, and fruits of forest-trees.

[2] With same general title as above, but bearing the author's name. Two volumes. Boston. Little, Brown & Co., 1875. Volume I contains the pines, oaks, beech, chestnut, hazels, hornbeams, walnuts, hickories, birches, alders, plane-trees, poplars, and willows: pp. xxii., 317, with 80 plates. Volume II contains the elms, ashes, locusts, maples, lindens, magnolias, liriodendrous, and most of the shrubs, pp. ix, and paging of former volume continued to 624, with 64 plates.

The botanical descriptions of this report, as free as possible from technical terms, were prepared by Mr. Emerson from the trees themselves, and the work was done with a thoroughness and care that entitle it to a permanent and honorable place in our literature. The arrangement is according to the natural system, and both editions, but more especially the second, give a concise account of the characteristics of the various orders and peculiarities of structure upon which they depend.

in its primitive condition everywhere abundant. Mr. Emerson in his report remarks:

In the narrow breadth of Massachusetts, the species of native-timber trees are more numerous than are found in any kingdom of Europe. We have nine large oak trees, three pines, two walnuts, two elms, two spruces, two cedars, besides the beech, the chestnut, the hornbeam, the lever-wood, the tupelo, the hoop-ash or nettle tree, the tulip-tree, the plane, the bass, the locust, the hemlock, the fir, the hackmatack, the cherry, the holly, several poplars, many willows, and a large number of smaller trees. Besides these it is found that all the valuable trees of Middle and Northern Europe flourish here as if they were native, and in some instances even surpass our native trees in the rapidity with which they grow. It thus appears that our soil and climate are perfectly well adapted to all kinds of wood which are found in temperate countries. It is only necessary to understand the character and habits of each, and to choose suitable soil and situation.[1]

In speaking of the profits of cultivation this author says:[2]

On nearly every farm in Massachusetts, more land is under cultivation than can be profitably managed. Many acres now in tillage might, with great advantage, be turned into forest, and the labor and manure which have been spread upon them be used in the better cultivation of the remaining acres. All that portion of every farm which is hilly or very stony, and all that does not readily bear good crops of corn and grass, may be, at comparatively little expense, sown with the seeds or set with the young plants of the most valuable forest-trees. The sowing or the planting should be very liberal, the young trees, when close together, protecting each other, and the poorer ones, when the plants become too close, affording excellent fuel, and serving, as they grow large, many important purposes. In this way a valuable permanent wood-lot might be added to farms the owners of which are now obliged, at large cost, to get their fuel from other sources. * * *

The most impracticable of our rocky hills were originally covered with trees. Sufficient portions of them remain in that state to show that all might, with a little pains, be redeemed to a profitable use. There are several kinds of trees which require very little soil; some of them need little more than a foothold in the earth. Several oaks, birches, and pines are often found growing among rocks where no soil can be seen. The rock-chestnut oak, the black birch, the red cedar, and the hackmatack rejoice in such situations. * * * On sedgy marsh and swamp, too wet and cold to be cultivated without extensive and costly draining, many acres, in the eastern part of the State, have been sown by a natural process with the seeds of the white cedar. The seeds, when shed, float upon the water, and are carried by spring tides and freshets, and left upon the surface of the ground. In the summer they spring up in countless multitudes. They may now be seen in different states of forwardness, some of them forming impenetrable thickets. What has been done in these instances by nature, indicates the process by which similar grounds may, by art, be reduced or restored to the condition of forest. By means of the trees above mentioned and others, almost every acre of the surface might be made productive. Even the rocky crowns of the sea-beaches, might be covered with beech-plums, pine trees, and birches.

Much is to be done for the improvement of the woodlands now existing. In some cases they are managed with great care; the best means of thinning, pruning, and felling are studied and practiced. But in many cases—indeed, in most instances—they are left in utter neglect. The consequences are often very visible. In the cedar-swamps just spoken of, the natural seed-sowing has been so profuse that plants spring up thick enough to almost cover the ground. Ten or twelve may sometimes be seen on a square foot. These grow up well together for a year or two. Afterwards they seem to be struggling for existence. The growth of all is retarded—almost stopped. In a few years the strongest overtop the others, which gradually die. Still the number left living is far too great for the ground, and few of them become fine and vigorous trees. All the side branches die for want of light and air, and the topmost shoot, never sufficient to form a shapely tree, is left alone. The same thing takes place in beech groves. Ten or twenty times as many plants spring up as can be sustained. They go on together vegetating, but hardly growing. I know instances of beech woods which have made little perceptible growth for twenty years. * * * The remedy is obvious. Every year, from the first, they need to be thinned. For the first few years the plants removed are of no value except for transplantation for fuel. Afterward they are of use in innumerable ways; the young cedars, larches, and chestnuts, for stakes and poles; hickories for walking-sticks; oaks and ashes for basket-work; lever-wood and hoop-ash for whip-stocks and levers; all of the five latter for hoops. The products of the thinning will thus obviously far more than repay the labor, even if this were not necessary for the welfare of the remaining trees.

[1] *Trees and Shrubs of Massachusetts*, 2d ed., i, 21.

[2] *Ibid.*, 25, 27.

In answer to circulars addressed to Mr. Emerson, about forty years since, for information upon subjects relating to woodlands in Massachusetts, the time required to grow timber to a size profitable for fuel was variously estimated at from 15, 17, 18, and 20, to 25, 30, and 35 years; the average of ten estimates being 23 years. Others spoke less definitely, as from 15 to 20, 17 to 30, 20 to 25, 20 to 30, 20 to 33, 20 to 40, 25 to 30, 15 to 35, and 30 to 35, for woods of mixed kinds. The average of fourteen of such estimates was 21 to 24, and a general average 24 years. Differences in soil, moisture, exposure to sun, air and winds, aspect, geological formation, drainage, and other causes would more or less influence the result aside from difference of species.

The white or gray birch was found most rapid of growth, springing quickly from the stump, and coming to a size for cutting, in from 10 to 20 years. The maple, ash, and black, yellow, and white birch, grew in from 20 to 25 years, oaks in from 20 to 23, and a mixed growth of white, black, and scarlet oak could be cut three times in a century. Cedar swamps, which grow from seed, cannot be profitably cut in less than 40 years. Pitch-pines require from seed from 40 to 60 years. In many places the experiment has been tried of burning over the surface, plowing and sowing with rye where the trees had been hard wood; this practice was condemned, but in pitch-pine it was recommended. The seedlings started much more rapidly where the surface had been softened by cultivation.

It is thought well established, that trees for fuel shoot up most vigorously when cut under 25 years of age, and that trees for reproduction should be cut as close to the ground as possible. Several suckers will be thrown out which will be curved at the base, thereby allowing more room to grow. As to the age at which stumps send up shoots most vigorously, there was little difference of opinion that young, healthy growing trees were best, from 15 to 20 years. Old trees lose the power, or, if shoots come up they soon die. In some cases these spring from the roots. Evergreens do not thus reproduce,[1] and the sugar-maple and beech but slightly. To secure reproduction the trees should be cut when not in leaf, and some careful observers preferred April or May. The quality of the wood cut appears to be better if cut early in winter. If the object is to destroy shoots, the trees should be cut in summer; but opinions differed as to the month, preferences being expressed for June, July, August, or midsummer. A very intelligent farmer preferred "August, or when the tree had attained its full growth for that season." Mr Emerson gave his approval of this period, as the wood has then formed but not hardened, or the materials laid up for future growth. A conclusive experiment had been made in a cleaving of young hickories, oaks, and birches, which had been made from time to time as leisure offered, from the 18th of March to the 18th of July. The part cut between June 18th and 30th was killed, and those cut before leaving out were most prompt in renewing their sprouts.

It was remarked by Mr. Emerson that most forest trees were injuriously affected by the sea-breeze, and that this could best be remedied by planting only the hardiest kinds along the seaward border, such as the sycamore, linden, and poplars, especially the Balm of Gilead, and many of the pines. Almost any trees might do it when growing in large masses. The effect does not extend far inland, and on the most exposed headlands, half a mile within a forest, the trees were found growing as large as was due to their depth of soil.

[1] The pitch-pine sprouts and grows for some time when cut, but generally dies down in a few years. The fallen trunk itself throws out sprouts the first summer.

List of the native trees of Massachusetts, with notes upon certain naturalized species.[1]

I.—CONIFERÆ: The Pine Family.

SECTION 1.—The Pine and Fir Tribe.

Pinus strobus (White Pine). Sometimes growing 130 or 140 feet high in the western part of the State and 100 feet to first limbs. They were formerly found larger, and fifty [now seventy] years ago several trees on rather dry land in Blandford measured, when felled, more than 220 feet. This tree is of rapid growth. In 1809 or 1810, a belt of pines and other trees were planted on two sides of the Botanic Garden in Cambridge, to protect it from the northwest winds. In 1841 and 1842, 10 measured 20 inches in diameter at the ground, showing nearly two-thirds of an inch annual growth in 31 years. The largest were 4 feet 8 inches around at 3 feet from the ground. They measured in 1874 6 feet 8 inches.

Pinus rigida (Pitch Pine). Commonly 40 to 50 feet high and 1 and 2 feet in diameter. Around Plymouth it grows larger; some 70 feet high, and one measured 5 feet 7 inches around at 3 feet from the ground. One measured 6 feet 7 inches. On the hills, in the southwest part of the State, they grow to 100 feet, and they have been seen in Massachusetts and Maine 4 to 5 feet in diameter. This tree grows more rapidly during the first 16 to 25 years; after which the circles of growth are narrower, there being rarely less than 10 and often 12 or 13 to an inch. When self-planted on the poorest of sandy land, it grows at the rate of an inch of diameter in 3 or 4 years in the first 25 years. This tree is somewhat difficult to transplant, but a person who had been very successful in this, recommended that the transplanting should be done when the new growth was about half an inch in length. The growth is most rapid after the third year and the best age for transplanting is 2 or 3 years. This tree has a great advantage in being able to endure salt water, and it is therefore desirable for sea-side planting. It is also useful as a nurse for tender deciduous trees.

Pinus resinosa (Red or Norway Pine). Not abundant, but in little detached clumps in various parts of the State. It grows as rapidly as the pitch-pine, and usually to greater height.

Abies Canadensis (Hemlock). Found in almost every part of the State, and in all varieties of soil. Very hardy, and highly suitable for hedges. It is at first of slow growth and very delicate, requiring shelter, but when once started, it grows with great rapidity.

Abies nigra (Black or Double Spruce). Hardy. Rarely grows to a large size.

Abies alba (White or Single Spruce). Rarely over 40 or 50 feet. Considerably rapid of growth, and its timber, like that of the preceding species, light, strong, elastic, and durable.

Picea balsamifera (Balsam Fir). The wood of this tree is deficient in hardness, strength, and elasticity, and the tree does not often attain a large size. It is hardy, easily transplanted, and grows with great vigor, but is short lived. It stands well against the wind, except from the sea. Of several planted in Cambridge in 1809 or 1810, the

---

[1] This list is derived almost wholly from the valuable report of Mr. Emerson, to which reference may be had for numerous important details, and full descriptions. In cases where other information is introduced, credit is given to the authorities from whence derived.

largest, in 1841, measured 4 feet 2 inches at the ground, and 3 feet 5 inches at 3 feet from the ground. The average growth was more than half an inch in diameter in a year.

Picea Fraseri (Double Balsam Fir). Found on the top of Saddle Back Mountain.[1]

The European Silver Fir (*Abies pectinata*), and Norway Spruce (*A. excelsa*), are introduced and grow finely, especially the latter.

Larix Americane (Hacmatack; Tamarack). Usually not a tall tree; in cold swamps in most parts of the State, coming to greatest perfection farther north; wood close, compact, and very durable, and valuable in ship-building.

The European Larch (*L. Europea*) is far superior in rapidity of growth, size, and variety of uses.

SECTION 2.—The Cypress Tribe.

Thuja occidentalis (American Arbor Vitæ). Rare in this State.

Cupressus thyoides (White Cedar). Only in swamps that are inundated a a part of the year, as between Boston and Mansfield, and Trenton and Bedford. Desirable for cultivation on account of durability of wood, and its growing where other trees will not.

Juniperus Virginiana (Red Cedar). On dry, rocky hills, and if exposed to strong winds, often bent and twisted. Found near Boston, sometimes 30 to 35 feet high. Wood very durable and used for many purposes.

Juniperus communis (Juniper). A prostrate shrub, difficult to exterminate, and of little use.

SECTION 3.—The Yews.

Taxus Canadensis (Yew; Ground Hemlock). A prostrate evergreen shrub, the stem trailing on the ground, or just beneath the surface, to a distance of 6 or 8 feet.

II.—CUPULIFERÆ: The Oak Family.

Quercus alba (White Oak). Found in every part of the State, but very rarely in the western; most abundant and of largest size in Essex County, and best on a moderately high, moist, loamy soil and on a southeast slope. The most valuable of trees, and most trees suitable for timber destroyed, so that it is rarely found of large size.

Quercus macrocarpa (Overcup White Oak). In Stockbridge, and the towns below in Berkshire County, where it is sometimes called pin-oak.

Quercus stellata Will., or *Q. obtusilola* Mch. (Post or Rough Oak). Only seen on Elizabeth Island and Martha's Vineyard and in Plymouth and Barnstable Counties; much valued for fuel, but not large enough for timber.

Quercus bicolor (Swamp White Oak). In low, moist grounds in all the eastern section of the State.

Quercus castœnea (Chestnut Oak). Only a few straggling individuals seen in Lancaster, Sterling, Russell, and Middleborough.

Quercus montana (Rock Chestnut Oak). Not frequent; chiefly confined to small districts or rocky hills; recommended for planting on steep rocky hills.

---

[1]Later examinations of this species appear to show that it does not occur as far north as Massachusetts.

Quercus chinquapin (Little Chincapin Oak). A shrub in most parts of the State, and in some instances to the exclusion of almost everything else.

Quercus tinctoria (Black or Yellow-barked Oak). Timber and bark valuable; more abundant in the eastern part of the State than any oak except the white; not often over 4 feet in diameter, and from 40 to 50 feet high.

Quercus coccinea (Scarlet Oak). Abundant in the eastern part, but found also in the middle and western.

Quercus palustris (Pin Oak). Found west of the Connecticut River, and more rarely in the eastern counties.

Quercus rubra (Red Oak). Found in every part of the State and in every variety of soil, even the poorest; of little value for fuel or timber, but of rapid growth.

Quercus ilicifolia (Bear Oak). A scrub-oak found in poor soils in all parts of the State.

Fagus sylvatica, var. *Americana* (American Beech). Grows in every part of the State, but of the greatest height in the western, and best in rocky, moist soils; of rapid growth, but generally considered short-lived.

Castanea vesca, var. *Americana* (Chestnut). Found in every part of the State; but it does not readily and abundantly ripen its fruit near the sea; very rapid in growth, and lives to a great age; highly recommended for cultivation.

Corylus Americana (American Hazel). A small shrub.

Corylus rostrata (Beaked Hazel). Smaller than the preceding.

III.—CARPINACEÆ: The Hornbeam Family.

Carpinus Americana (American Hornbeam). A small tree, found in every part of the State, and in a wide variety of soil. One, near Chester village, measured 3 feet 9 inches around above the bulge of the roots, and was about 30 feet high.

Ostrya Virginica (American Hop Hornbeam). Sometimes called *lever-wood*, or *iron-wood.* Seldom grows to a large size, but sometimes four or five feet around at the ground.

IV.—JUGLANDACEÆ: The Walnut Family.

Juglans cinerea (Butternut). Abounds in the Hoosic Mountains and in the Connecticut Valley, and of rapid growth when young.

Juglans nigra (Black Walnut). Found in the State, but most abundant in the West.

Carya alba (Shellbark Hickory). Flourishes in nearly every part of the State. In the maritime districts, and in sandy soils, it is rarely found. It is most abundant in the neighborhood of Boston, and in Middlesex, Essex, and Worcester Counties.

Carya tomentosa (Mockernut). It prevails in the eastern part of the State, particularly in the vicinity of Boston.

Carya porcina (Pignut Hickory). More frequent than any other species, and sometimes growing to four feet in diameter.

Carya amara (Bitternut Hickory). Abundant in Chelsea and Brookline, and found in Worcester County, and along the Connecticut.

V.—BETULACEÆ: The Birch Family.

Betula lenta (Black or Sweet Birch). From the dark color of its bark sometimes called the cherry-birch.
Betula excelsa (Yellow Birch). Abundant and growing to a large size. One measured in Lanesborough was 10 feet 7 inches around.
Betula nigra (Red Birch). Abundant on the Merrimac River, and on Spicket River and tributaries, and in neighboring swamps.
Betula papyracea (Canoe Birch). Does not grow to a large size in this State.
Betula populifolia (White or Gray Birch). A small tree, but of rapid growth, and valuable for this reason.
Betula glandulosa (Dwarf Birch). Found in a few places in this State.
Alnus serrulata (Common Alder). Abounds along brooks and in swamps. Generally small, but in deep swamps, sometimes 6 to 8 inches in diameter, and 20 or 30 feet high.
Alnus incana (Speckled Alder). Found in every part of the State, and in same situation as the former.

VI.—MYRICACEÆ: The Wax-Myrtle Family.

Myrica gale (Sweet Gale: Dutch Myrtle). A bush, in places inundated a part of the year.
Myrica cerifera (Bay Myrtle). A shrub in a great variety of soils and situations.
Comptonia asplenifolia (Sweet Fern). A small bush; common.

VII.—PLATANACEÆ: The Plane Tree Family.

Platanus occidentalis (Buttonwood). Of very rapid growth, and growing to a large size, but the wood perishable, and of little value.

VIII.—SALICINÆ: The Willow Family.

Populus grandidentata (Large Poplar). Grows abundantly in the western and northern parts of the State, and to a height of 70 to 80 feet, with a diameter of 16 to 24 inches.
Populus tremuliformis [1] (American Aspen). Abundant.
Populus candicans (Balm of Gilead). Introduced and much cultivated for ornament.
Populus lævigata (River Poplar). Grows rapidly, and to a large size, on the Connecticut, above and below Springfield, on the Chicopee, and at various places on Westfield River.
Salix tristis (Sage Willow: Dwarf Gray Willow). Dry sandy plains; a small shrub.
Salix humilis (Low Bush Willow). A shrub 6 or 8 feet high.
Salix discolor (Two-colored, Bog, or Glaucous Willow). In wet swamps at Dedham.
Salix eriocephala, Mchx. *S. prinoides*, Pursh. (Silky-headed Swamp Willow). A small tree in swamps.
Salix sericea (Silky-leaved Willow). A shrub or small tree; promises to be useful in basket-making.

---

[1] *P. tremuloides*, of most botanists. Objections are stated with regard to this name on account of etymological construction.

Salix cordata (Heart-leaved Willow). A low tree on the Connecticut, Nashua, and other rivers of the State.
Salix rostrata (Beaked Willow). Found in all varieties of soil, but growing best in moderately rich, moist grounds, in open woods.
Salix alba (White Willow). Introduced, and extensively planted in this country.
Salix vitellina (Yellow Willow : Golden Osier). Introduced, and more extensively propagated than any other foreign willow.
Salix fragilis (Crack Willow). Introduced; a small tree of rapid growth.
Salix Russelliana (Bedford Willow). Introduced. A tree of rapid growth.
Salix nigra (Black Willow). A small tree.
Salix lucida (Glossy Willow). A small tree found in all parts of the State, and of New England.
Salix Babylonia (Weeping Willow). Introduced.

IX.—ARTOCARPÆ: The Bread-Fruit Family.

Morus rubra (Red Mulberry). Found wild on Westfield River. Other species, as the *M. alba.*, *M. nigra*, &c., are introduced.

X.—ULMACEÆ: The Elm Family.

Ulmus Americana (American, or White Elm). Found throughout the State, and a most magnificent tree. It grows in almost any soil, but best on rich, moist ground, as on the banks of large rivers. Mr. E. mentions many specimens of this tree in the State noted for their historical associations or great size, and measurements of several are given. The seed ripens in May or June, and should be sown at once. It bears transplanting well, and bears mutilation remarkably.
Ulmus fulva (Slippery Elm). Smaller than the preceding; rare in the eastern part of the State, but more abundant in the western counties. The largest tree seen measured 6 feet 10 inches at 4 feet from the ground.
Ulmus campestre (Common European Elm). Introduced and growing rapidly and luxuriantly. One is mentioned in Roxbury that measures 17 feet 5 inches at 3 feet from the ground, and 15 feet 10 inches at 5 feet.
Ulmus montana (Scotch Elm). Introduced.
Celtis occidentalis (Nettle Tree). Found here and there, but not in quantities, throughout the State; indeed it is so rare that it has no fixed common name.
Celtis crassifolia (Hack-berry). Found on the banks of the Connecticut and near Lowell.

XI.—SANTALACEÆ: The Sandal-Wood Family.

Nyssa multiflora (Tupelo). Called in Bristol and other southeastern counties, the snag-tree or horn-pine, and in the western part of the State, the pepperidge; it is also called hornbeam, but nowhere the gum-tree, as it is known South. Wood so difficult to split that little use is made of it. A remarkable tree of this species is described as growing in Cohasset that is 11 feet around at the roots.

XII.—LAURINÆ: THE CINNAMON FAMILY.

Sassafras officinale (Sassafras). Grows in this State seldom over 30 feet high, and a foot in diameter, yet larger specimens have been found. It grows in almost every part of the State.

Benzoin odoriferum (Fever-Bush; Spice-Bush). A shrub, 4 to 10 feet in height.

XIII.—THYMELACEÆ: THE MEZEREUM FAMILY.

Dirca palustris (Leather-Wood). A small shrub in wet, marshy and shady places.

XIV.—EMPETRACEÆ: CROWBERRY FAMILY.

Oakesia Conradi (Plymouth Crowberry). A low, heath-like shrub.

XV.—OLEACEÆ: THE OLIVE FAMILY.

Ligustrum vulgare (Common Privet). Naturalized.

Syringa vulgaris (Lilac). Naturalized.

Fraxinus acuminata (White-Ash). Found throughout the State, but flourishes best in a deep loamy soil, near the banks of a river, or in a moist meadow.

Fraxinus pubescens (Red Ash). On rich intervale land on the Connecticut River; often over 3 feet in diameter, and 50 to 60 feet high. In Springfield one was measured that was 10 feet 4 inches around at the ground and 9 feet at a yard from the ground. This is a spreading tree, and does not grow to great height except in the forest.

Fraxinus sambucifolia (Black Ash). Mostly confined to swamps and the muddy banks of rivers where the soil is permanently moist.

Fraxinus excelsior (European Ash). Introduced, and found to grow as vigorously as any of the native species.

XVI.—AQUIFOLIACEÆ: THE HOLLY FAMILY.

Ilex opaca (American Holly). Found plentifully in Quincy, at Cohasset, and especially at New Bedford, and on Naushon Island.

Nemopanthes Canadensis (Wild Holly). A shrub in the eastern and middle part of the State.

Prinos verticillata (Black Alder). A shrub growing in moist moods.

Prinos lævigatus (Single-berry Black Alder). A shrub growing in deep swamps.

Prinos glaber (Ink-berry). A delicate evergreen shrub; of late much cultivated.

XVII.—RUBIACEÆ: THE MADDER FAMILY.

Cephalanthus occidentalis (Button Bush). A small shrub along streams.

Mitchella repens (Partridge Berry.) A common, trailing evergreen plant.

XVIII.—CAPRIFOLIACEÆ: THE HONEYSUCKLE FAMILY.

Linnæa borealis (Twin Flower.) A common, creeping evergreen herb, with creeping woody stem.

Triosteum perfoliatum (Fever Root). A coarse looking plant, found in shady places.

Lonicera hirsuta (Hairy Honeysuckle). A hardy climbing plant, found in damp rocky places.
Lonicera parviflora (Small-flowered Yellow Honeysuckle). Abundant in western part of the State.
Lonicera ciliata (Fly Honeysuckle). A shrub growing among rocks in Essex County.
Lonicera cœrulea (Hairy Fly Honeysuckle). In bogs in the western part of the State.
Diervilla trifida (Three-Flowered Bush Honeysuckle.) A variety occurs with narrow leaves.

XIX.—VIBURNEÆ: The Elder Family.

Sambucus pubens (Panicled Elder). In Worcester County, on every side of the Wachusett Mountain.
Sambucus Canadensis (Common Elder). Found in every part of the State.
Viburnum nudum (Naked Viburnum). A slender shrub in swamps and wet woods.
Viburnum lentago (Sweet Viburnum). A small tree growing 15 to 20 feet high.
Viburnum dentatum (Arrow-Wood). A shrub or small tree common in every part.
Viburnum acerifolium (Maple-Leaved Arrow-Wood). A low shrub, common in rocky woods.
Viburnum opulus (High Cranberry). A low tree. A variety is cultivated as the "Snow-Ball Tree."
Viburnum lantanoides (Wayfaring Tree; Hobble Bush). A small tree.

XX.—ERICACEÆ: The Heath Family.

Andromeda polifolia (Water Andromeda). A low shrub, in boggy places.
Cassandra calyculata (Dwarf Cassandra). A low evergreen, in swamps and boggy places.
Lyonia paniculata (Panicled Lyonia). A bushy shrub, with conspicuous white flowers.
Zenobia racemosa (Clustered Zenobia). A low shrub, much resembling whortleberry bushes.
Clethra alnifolia (Alder-leaved Clethra). A shrub in deep bogs.
Epigea repens (Mayflower). A trailing evergreen, blossoming in early spring.
Gaultheria procumbens (Partridge Berry). A delicate fragrant evergreen plant.
Arctostaphylos uva-ursi (Bear Berry). A shrubby evergreen plant, on dry sandy plains.
Rhododendron maximum (Rose Bay). In great abundance in a swamp in Medfield, and in a smaller one in Medfield.
Rhododendron viscosum (Swamp Pink, Wild Honeysuckle). Open woods; abundant.
Rhododendron nudioflrum (Upright Honeysuckle). In the southern part of the State, near Rhode Island.
Rhodora Canadensis (Canada Rhodora). Found near Boston, and not unfrequently in wet lands in other parts of the State.
Kalmia latifolia (Mountain Laurel). On shores of the basin at Cohasset; on Buzzard's Bay; near Newburyport and Lowell; in Worcester County, and on both declivities of the Green Mountains.

Kalmia angustifolia (Narrow-leaved Laurel). A low evergreen shrub.
Kalmia glauca (Pale Laurel). In Richmond and a few other places in the State.
Ledum latifolium (Broad-leaved Labrador Tea). In sphagnous swamps in Pittsfield, Richmond, and Hubbardston.

XXI.—VACCINIEÆ: The Whortleberry Family.

Gaylussacia resinosa (Black Whortleberry). A shrub 18 to 36 inches high, on rocky hills.
Gaylussacia frondosa (Dangleberry). In moist situations on the edges of woods.
Gaylussacia dumosa (Bush Huckleberry). In Manchester; rare.
Vaccinium stamineum (Deer Berry). At Southampton lead-mine, and elsewhere in the western part of State.
Vaccinium corymbosum (High-bush Huckleberry). A shrub 4 to 9 feet high, in swamps.
Vaccinium virgatum, Muhlenberg: *V. vacillans*, Gray (Blue Huckleberry). Common.
Vaccinium Pennsylvanicum (Low Blueberry). Common.
Vaccinium vitis-ideæ (Cowberry). In Danvers; rare.
Oxycoccus macrocarpa (Common Cranberry). Found in every part of State.
Oxycoccus palustris (European Cranberry). Nantucket, Pittsfield, and near Sherburne.

XXII.—CORNACEÆ: The Cornus Family.

Cornus alternifolia (Alternate-leaved Cornel). A shrub sometimes 20 feet high or more and 5 inches in diameter.
Cornus circinata (Round-leaved Cornel). A shrub 7 to 10 feet high.
Cornus stolonifera (Red-stemmed Cornel). Plentiful in swamps in Berkshire.
Cornus paniculata (Panicled Cornel). A slender plant; common.
Cornus sericea (Silky Cornel). Abundant near Boston and in the middle of the State.
Cornus florida (Flowering Dogwood). Growing sometimes 30 feet high and 10 inches in diameter, but usually much less.
Cornus Canadensis (Dwarf Cornel). An humble plant in damp woods.

XXIII.—HAMAMELACEÆ: The Witch Hazel Family.

Hamamelis Virginiana (Witch Hazel). In moist woods, 10 to 20 feet high. One was seen 22 feet high and 10 inches around.

XXIV.—GROSSULACEÆ: The Currant Family.

Ribes cynosbati (Prickly Gooseberry).
Ribes hirtellum (Common Wild Gooseberry).
Ribes rotundifolium (Round-leaved Gooseberry).
Ribes lacustre (Swamp Gooseberry).
Ribes floridum (Large-flowering Currant).
Ribes prostratum (Mountain Currant).

XXV.—CACTACEÆ: The Cactus Family.

Opuntia vulgaris (Prickly Pear). Nantucket.

XXVI.—ROSACEÆ: The Rose Family.

Spiræa opulifolia (Nine-Back). Presumed to occur in State, as it is found both North and South.
Spiræa salicifolia (Queen of the Meadows). Abounds in wet places.
Spiræa tomentosa (Steeple-Bush). A leafy shrub, 2 to 5 feet high in wet places.
Rubus odoratus (Flowering Raspberry). Common in most parts of the State.
Rubus strigosus (Wild Red Raspberry).
Rubus villosus (High Blackberry).
Rubus frondosus (———).
Rubus Canadensis (Low Blackberry).
Rosa lucida (Early Wild Rose). Common to the eastern part.
Rosa Carolina (Swamp Rose). In wet grounds.
Rosa nitida (Shining Rose). In a few places, in low grounds.
Rosa rubiginosa (Sweet Brier). Probably introduced, but common.

XXVII.—POMACEÆ: The Apple Family.

Cratægus crus galli (Cock-spur Thorn). Common.
Cratægus coccinea (Scarlet-fruited Thorn). A low, round-headed, much-branched tree. Common.
Cratægus tomentosa (Pear-leaved Thorn). A common and hardy thorn.
Cratægus punctata (Dotted-fruited Thorn). In wet grounds.
Pyrus communis: P. malus (Pear and Apple). Introduced.
Pyrus Americana (Mountain Ash). In mountainous locations.
Pyrus arbutifolia (Choke-Berry). A slender, branching shrub. Common.
Amelanchier Canadensis (Shad Bush). A small tree, of which there are two well-marked varieties: the June-Berry (*A. botryapium*) and Swamp Sugar-Pear (*A. ovalis*).

XXVIII.—AMYGDALEÆ: The Almond Family.

Prunus maritima (Beach Plum). On islands and beaches within twenty miles or more from the sea.
Prunus Americana (Yellow Plum). Found farther north, and presumed to occur within this State.
Prunus insititia (Wild Bullace Tree). In a few places near Boston.
Prunus Pennsylvanica (Northern Red Cherry). Common throughout the State.
Prunus pumila (Sand Cherry). In Milton; rare in other parts of State.
Prunus serotina (Black Cherry). A tree 40 to 50 feet high; common.
Prunus Virginiana (Choke Cherry). A shrub or small tree; common.

XXIX.—LEGUMINOSÆ: The Bean Family.

Robina pseud acacia (Common Locust Tree). Never a first-class tree in this State; not known to be a native of the State.
Gleditschia tricanthos (Honey Locust). Introduced.
Gymnocladus Canadensis (Kentucky Coffee Tree). Occasionally cultivated.
Cercis Canadensis (Judas Tree). Occasionally cultivated.

XXX.—VITACEÆ: The Vine Family.

Vitis labrusca (Fox Grape). Common in low, rich grounds.

Vitis æstivalis (Summer Grape). Several varieties of this species have been noticed; some of which have been described as separate species.
Vitis riparia (River Grape). On Westfield River and in Worcester County.
Ampelopsis quinquefolia (Virginia Creeper). Common.

XXXI.—RHAMNACEÆ: The Buckthorn Family.

Rhamnus catharticus (Common Buckthorn). Found near Boston; probably introduced from Europe.
Rhamnus alnifolius (Alder-leaved Buckthorn). In moist grounds.
Ceanothus Americanus (New Jersey Fern). A low, bushy shrub; common.

XXXII.—CELASTRACEÆ: The Staff-Tree Family.

Staphylea trifolia (Three-leaved Bladder Nut). A tall shrub or small tree.
Celastrus scandens (Staff-Tree). A twining shrub.

XXXIII.—ACERACEÆ: The Maple Family.

Acer rubrum (Red Maple). Abundant in swamps and low grounds.
Acer casycarpum (White Maple). Sandy or gravelly banks of clear streams throughout middle and western parts of State.
Acer saccharinum (Sugar Maple). Common; easily cultivated and very valuable.
Acer Pennsylvanicum (Striped Maple; Moose Wood). Abundant in middle and western parts of State and in Essex County.
Acer spicatum (Mountain Maple). A small tree grown in rocky places.

XXXIV.—ANACARDIACEÆ: The Sumac Family.

Rhus tryhhina (Staghorn Sumac). A tall shrub, sometimes a small tree 25 feet high, and 4 to 5 inches in diameter.
Rhus glabra (Smooth Sumac.) In barren fields and by the side of woods, sometimes overspreading considerable tracts in neglected fields.
Rhus copallina (Dwarf Sumac). On very rocky hills and roadsides, usually 3 to 5 feet high, in rare instances 18 to 20, and 4 to 5 inches in diameter.
Rhus venenata (Poison Sumac.) In swamps, 8 to 10 feet high, and in rare cases 15, and 2 to 3 inches diameter. Some persons are not affected by the poison of this plant, and opposite effects are sometimes produced on different members of the same family. It is thought that a varnish analogous to that obtained from the varnish-yielding sumac of Japan could be prepared from this plant, and some experiments tend to confirm this belief.
Rhus toxicodendron (Poison Ivy). A clinging plant, less poisonous than the preceding.
Rhus aromatica (Fragrant Sumac.) Near the western border of the State.

XXXV.—XANTHOXYLACEÆ: The Prickly Ash Family.

Xanthoxylum Americanum (Prickly Ash). Found only in one place on a southern slope in Medford.

XXXVI.—TILIACEÆ: The Linden Family.

Tilia Americana (Basswood, Linden, Lime Tree). Found in every part of the State. One at Natick measured 16 feet 6 inches at the ground, and 13 feet 4 inches at 4 feet from the ground.

XXXVII.—CISTACEÆ: The Rock Rose Family.

Helianthemum Canadense (Sun Rose). Two marked varieties grow near Boston, the *H. Canadense* and *H. ramuliflorum* of Pursh.
Lechia major (Large Pinweed).
Lechia thymifolia (Thyme-leaved Pinweed).
Lechia minor (Small Pinweed).
Hudsonia tomentosa (Downy Hudsonia). On the sea-coast in Essex County.
Hudsonia ericoides (Heath-like Hudsonia). On Nantucket and Martha's Vineyard.

XXXVIII.—BERBERIDÆ: The Barberry Family.

Berberis vulgaris (Common Berberry). Common in many places.

XXXIX.—MENISPERMACEÆ: The Moonseed Family.

Menispermum Canadense (Canada Moonseed). A twining plant.

XL.—MAGNOLIACEÆ: The Magnolia Family.

Magnolia glauca (Small Magnolia). In a sheltered swamp near Cape Ann, and elsewhere in Essex County.
Liriodendron tulipifera (Tulip Tree.) In several towns on Westfield River, especially in Russell; rare in the eastern part of the State.

The division comprising the monocotyledonous plants is represented in Massachusetts by the following species: *Smilax rotundifolia* and *S. herbacea*, both climbing plants, and having no economical importance.

It has been found that the European larch thrives along the coast in Eastern Massachusetts, and its introduction has been much encouraged of late, not because it is considered a more valuable tree than some of the native trees, but because it will thrive and grow rapidly on worn-out gravelly soils, where better trees, such as the oak, ash, and hickory, would fail.

The native white pine (*Pinus strobus*) does well in Eastern Massachusetts, and a great many small tracts have been planted within the last thirty years in Taunton, Middleborough, Bridgewater, and other towns. The leading shoot is often eaten off by a weevil, by which its future growth for timber may be injured, but the tree survives this injury and produces a wood useful for a great many purposes.

Prof. C. S. Sargent, in enumerating the woods suitable for cultivation in Massachusetts, says:

> The finest hickories are not produced in Massachusetts, although in the western part of the State, especially in the valley of the Connecticut, and in other favorable situations, the natural growth of this tree is fine enough to warrant its extensive cultivation. The hickories should be cultivated in the same manner as recommended for the ash, the young plants being equally valuable for hoop-poles, walking-sticks, and similar purposes, while the lumber cut from the large trees brings a higher price than any other produced in the Northern States. It is used extensively in carriage-building and for ax-handles, in which form it is carried all over the world. Hickory makes

better fuel than any other wood with which we are acquainted, and is always the standard by which the value of other woods for this purpose is estimated. The best hickory is worth, in the Boston market at the present time, $100 the 1,000 feet. In the form of firewood it now seldom comes to the Boston market, where it readily commands, however, $16 the cord, and in nearly every part of the State it is worth from $8 to $10 a cord for curing hams and bacon, for which purpose no other wood supplies its place. The shagbark hickory (*Carya alba*, Nutt.), which also produces the finest fruit, and the pignut hickory (*Carya porcina*, Nutt.), are the most valuable species for cultivation in Massachusetts.[1]

The efforts made in Massachusetts to promote the cultivation of forest trees by premiums date from a relatively remote period. Among the prizes offered by the State Society for Promoting Agriculture, in 1804, was the following:

6. To the person who shall produce from seed the best growth of trees, not less than 600 in the whole, and in the proportion of 2,400 to the acre, of any of the following kinds of forest trees, viz: Oak, ash, elm, sugar-maple, beech, black or yellow birch, chestnut, walnut, or hickory, $25; if all of oak, $50; claims to be made on or before the 1st of October, 1806.

A prize offered in Essex County, Massachusetts, by Richard S. Fay, of Lynn, September 25, 1847, of $100 for the best plantation of oaks, "not less than one acre, the prevailing species to consist of the white and the black or yellow oak, to be grown from the acorn planted this autumn, or in the spring, on land not now under tillage or in mowing." The prize was to be awarded in 1852, and the money in the mean time was to be placed at interest for the benefit of the successful competitor. Notice was to be given of intention to compete, so that the premises might be viewed and registered.

The gentleman offering the prize remarked:

"I name a small sum and a small piece of land, in order to bring it within reach of every farmer's son whose father has—and what farmer has not?—an idle acre and unprofitable land. It will require no great expenditure of time and no money to enable any person to plant out an acre, and the advantage to the person so doing would far exceed the labor bestowed, even if an unsuccessful competitor. Should there be ten or more entries for this year, I pledge myself to renew the prize for the next ten years upon the same terms.

The Massachusetts Society for Promotion of Agriculture, in April, 1876, offered premiums of $1,000, $600, and $400, for first, second, and third best plantations of not less than five acres, to be made of European larch, except in Barnstable, Dukes, and Nantucket counties, in which the Scotch pine or the Corsican fir, or both the latter, must be used. The plantations must originally consist of at least 2,700 trees to the acre, and the land must be poor, worn out, or unfit for agricultural use.

They also offered $600 and $400 for first and second best plantations of five acres, or more, of American white ash, at first having 5,000 trees to the acre.

The plantation must be made in the spring of 1877, and the prizes are to be awarded in the summer of 1887.[2] The directions for planting were as follows:

Larch and pine.

When the nature of the soil will permit, shallow furrows 4 feet apart should be run one way across the field to be planted. This is best done during the autumn pre-

[1] *Agriculture of Massachusetts*, 1875–'76, p. 268.

[2] We learn by correspondence, dated November 16, 1877, that but two competitors have appeared for the prizes offered by this society, one in Andover and the other in Groton. In each of these cases five acres of European larch have been planted. Smaller prizes were offered in the summer of 1877, ranging from $75 to $250, but no entries had been made. A prize offered by the society some sixteen or seventeen years ago, amounting to $1,000, was paid in 1870 to the Hon. Ben: Perley Poore, the only competitor who did not withdraw from the contest before payment was due.

vious to planting. Then by planting in the furrows, and inserting the plants 4 feet apart in the rows, the whole land will be covered with plants standing 4 feet apart each way. Planted at this distance, 2,720 plants will be required to the acre. On hilly, rocky land, which is especially recommended for the cultivation of the European larch, and where it is impossible to run furrows, it will be only necessary to open with a spade, holes large enough to admit the roots of the plants, care being taken to set them as near 4 feet each way as the nature of the ground will admit. In very exposed situations on the sea-coast, it is recommended to plant as many as 5,000 trees to the acre, the plants being inserted more thickly on the outsides of the plantations in order that the young trees may furnish shelter to each other.

It is imperative to plant the larch as early in the season as the ground can be worked. No other tree begins to grow so early, and if the operation of transplanting it is delayed until the new shoots have pushed, it is generally followed by the destruction of the plant.

The Scotch and Corsican pines can be planted up to the 1st of May.

Ash.

Land in condition to grow corn or an average hay crop is suited to produce a profitable crop of white ash. Deep, moist land, rather than that which is light and gravelly, should be selected for this tree. The land should be plowed, harrowed, and made as mellow as possible during the autumn previous, that the trees may be planted as soon as the ground can be worked in the spring.

As soon as the frost is out, mark out the field with furrows 4 feet apart, and insert the trees 2 feet apart in the rows. This will give 5,445 plants to the acre, which, at the end of ten years, must be thinned one-half. These thinnings are valuable for barrel-hoops, &c.

It is recommended to cultivate between the rows for two or three years to keep down the weeds and prevent the soil from baking. At the end of that time the ground will probably be entirely shaded by the trees, and further cultivation will not be necessary.

General directions for tree-planting.

Be careful not to expose the roots of trees to the wind and sun more than is necessary during the operation of transplanting. More failures in tree-planting arise from carelessness in this particular than from any other cause.

To prevent this, carry the trees to the field to be planted in bundles covered with mats; lay them down, and cover the roots with *wet* loam, and only remove them from the bundles as they are actually required for planting.

In planting, the roots should be carefully spread out and the soil worked among them with the hand.

When the roots are covered press the earth firmly about the plant with the foot.

Insert the plant to the depth at which it stood before being transplanted.

Select, if possible, for tree-planting a cloudy or a rainy day. It is better to plant after the middle of the day than before it.

All young plantations *must be protected* from cattle and other browsing animals—the greatest enemies, next to man, to young trees and the spread of forest growth.

Directions for procuring young trees.

Selected plants of the European larch and the Scotch pine, about 1 foot high and very thrifty, can be imported from England, and delivered at the railroads in Boston at from $5 to $6 per 1,000, the price varying with the price of gold and the rate of exchange and freight. Imported plants of the Corsican pine of the same size will cost at present prices about $10 per 1,000 delivered in Boston.

All persons, whether competitors for the society's prizes or not, desiring to import trees of these varieties, can do so by sending their orders to Francis Skinner, Brookline, Mass., before December 1. Mr. Skinner will transmit all orders for not less than 1,000 trees to England, and will see that the trees, on their arrival in Boston, are passed through the custom-house, and forwarded at the least possible expense to the persons ordering them.

As Mr. Skinner undertakes this duty solely from a desire to facilitate tree-planting in his native State, and not for the purpose of any personal gain, he cannot be held responsible in any way by the persons desiring to order through him.

Mr. Anthony Waterer, nurseryman, Woking, England, with whom special arrangements have been made to prepare trees for planting in Massachusetts, guarantees their safe arrival in this country, provided his orders are received early enough to permit his shipping the larch during the months of December and January, and the pines not later than February 15.

The importation of these trees cannot, in safety, be made after these dates. If it is delayed later, the plants are liable to heat in transit, and to make a soft, unnatural

growth, which generally causes their death. As the plants will arrive some weeks before they can be planted, importers should provide some accommodation for their reception. The plants must be unpacked as soon as received, the roots moistened, and then heeled into a frame, cold cellar, or shed, in which the temperature will be at about the freezing point, but where they can be guarded from extreme cold and the sun's rays. As a little soil will be required to put over the roots at this time, importers should lay in a supply in the autumn for this purpose, and keep it away from the frost until needed.

American white ash, one or two years old, and about 1 foot high, can be procured for from $5 to $10 per 1,000 from the following well-known American nurserymen: Robert Douglas, Waukegan, Ill.; Thomas Meehan, Germantown, Pa., and the Lawrence Nursery Company, Sturgeon Bay, Wis.

STATISTICS OF FORESTRY AND FOREST PRODUCTS, FROM THE STATE CENSUS, AT DIFFERENT PERIODS.

Areas of land and of woodland (1875).

	Acres.
Total area of State, 7,800 square miles, equal to	4,992,000
Area in farms	3,402,368
Area in lakes, rivers, and ponds	293,000
Cities, villages, cemeteries, commons, &c	500,000
Area in railroads (20,000) and roads (140,000)	160,006
Detached and non-resident lands (81,759) and reservoirs (32,367)	114,120
Not accounted for	472,506

Woodland (1875).

Counties.	In cities.		Excluding cities.		Total woodlands.		Total value.
	Acres.	Average value per acre.	Acres.	Average value per acre.	Acres.	Average value per acre.	
Barnstable	....	....	31,985	$6 89	31,985	$6 89	$220,482
Berkshire	....	....	111,689	19 09	111,689	19 09	2,132,488
Bristol	11,252	$36 86	80,050	18 51	91,302	20 77	1,896,478
Dukes	....	....	9,204	12 42	9,204	12 42	114,334
Essex	2,783	44 95	30,499	33 36	33,282	34 32	1,142,546
Franklin	....	....	74,837	19 40	74,837	19 40	1,451,724
Hampden	3,930	70 67	69,738	19 01	73,668	21 77	1,603,504
Hampshire	....	....	62,444	19 88	62,444	19 88	1,241,289
Middlesex	1,468	213 80	100,783½	33 20	102,251½	35 80	3,660,338
Nantucket	....	....	173¾	19 86	173¾	19 86	3,440
Norfolk	....	....	51,724¼	28 39	51,734¼	28 39	1,467,369
Plymouth	....	....	101,229¾	16 96	101,229¾	16 96	1,717,196
Suffolk	586	320 89	14	153 57	600	316 98	190,190
Worcester	3,767¾	115 71	182,244½	26 29	186,012¼	28 10	5,227,780
Total	23,786¾	72 88	906,615¾	22 40	930,402½	23 72	22,069,158

Percentages.

Of woodlands in cities to total woodlands	2.6
Of woodlands to total land in farms	27.3
Of woodlands to total area of State	18.6
Of value of woodlands to total value of land of all kinds	18.9

Domestic forest products at different periods.

	1845.	1855.	1865.	1875.
Fire-wood, total value	$1, 010, 328	$2, 960, 915	$2, 189, 044	$404, 493
cords	368, 554	671, 910	506, 101	636, 059
value per cord	$2 74	$4 41	$4 33	$3 77
Lumber, total value	$921, 106	$3, 664, 462	....	$175, 707
Maple sugar, total value	$41, 443	$52, 293	$99, 946	$123, 013
pounds	573, 048	520, 441	556, 823	11, 082, 203
value per pound	$0 07	$0 10	$0 18	$0 11
Maple molasses, total value	....	....	$1, 426	$27, 235
gallons	....	....	1, 039	23, 015
value per gallon	....	....	$1 37	$1 18
Railroad sleepers, total value	....	....	$240	$204, 171
number	....	....	600	458, 544
value each	....	....	$0 47	$0 44

Summary of forest products by counties (1875).

Articles and counties.	For sale.		For use.		Total.	
	Quantities.	Value.	Quantities.	Value.	Quantities.	Value.
BARK.	*Cords.*		*Cords.*		*Cords.*	
Berkshire	3, 033	$22, 324	3	$27	3, 036	$22, 351
Bristol	9	64	....	....	9	64
Essex	63	642	....	....	63	642
Franklin	999	7, 475	10	50	1, 009	7, 525
Hampden	1, 015	6, 982	35	135	1, 050	7, 117
Hampshire	535	3, 774	600	1, 600	1, 135	5, 374
Middlesex	49	405	6	25	55	430
Norfolk	4	40	....	....	4	40
Plymouth	8	73	....	....	8	73
Worcester	1, 320	10, 204	19	89	1, 339	10, 293
Total	7, 035	51, 983	673	1, 926	7, 708	53, 909
CHARCOAL.	*Bushels.*		*Bushels.*		*Bushels.*	
Berkshire	560, 747	$61, 572	....	....	560, 747	$61, 572
Bristol	60, 825	10, 160	71	45	60, 896	10, 205
Essex	....	....	260	42	260	42
Franklin	48, 300	4, 928	10	2	48, 310	4, 930
Hampden	33, 150	4, 936	150	38	33, 300	4, 977
Hampshire	73, 800	8, 357	160	27	73, 960	8, 384
Middlesex	20, 196	3, 230	....	....	20, 196	3, 230
Norfolk	34, 820	6, 384	50	10	34, 870	6, 394
Plymouth	172, 973	19, 024	161	28	173, 134	19, 052
Worcester	9, 000	1, 670	400	100	9, 400	1, 770
Total	1, 013, 811	120, 261	1, 262	292	1, 015, 073	120, 556
FIRE-WOOD.	*Cords.*		*Cords.*		*Cords.*	
Barnstable	6, 706	$30, 431	2, 453	$11, 837	9, 158	$42, 268
Berkshire	38, 027	132, 320	27, 959	98, 490	65, 986	230, 810
Bristol	38, 197	158, 675	12, 878	47, 225	51, 075	205, 900
Dukes	283	1, 597	788	4, 676	1, 071	6, 273
Essex	24, 452	117, 952	8, 706	42, 927	35, 158	160, 879
Franklin	31, 122	118, 640	25, 680	98, 796	56, 802	217, 436
Hampden	30, 154	120, 462	21, 722	72, 138	51, 876	192, 600
Hampshire	29, 107	103, 057	24, 973	89, 774	54, 080	192, 831
Middlesex	53, 035	226, 320	22, 137	86, 304	75, 172	312, 624
Norfolk	20, 541	85, 964	6, 454	29, 081	26, 995	115, 045
Plymouth	34, 053	130, 678	16, 923	53, 252	50, 976	183, 930
Suffolk	159	990	8	66	167	1, 056
Worcester	110, 558	351, 351	46, 985	187, 490	157, 543	538, 841
Total	416, 394	1, 578, 437	217, 666	822, 056	636, 059	2, 400, 493
MAPLE SUGAR.	*Pounds.*		*Pounds.*		*Pounds.*	
Berkshire	149, 786	$17, 080	115, 599	$13, 087	265, 385	$30, 167
Franklin	160, 258	18, 838	212, 181	23, 433	372, 439	42, 271
Hampden	97, 412	10, 711	51, 885	5, 403	149, 297	16, 114
Hampshire	169, 306	20, 728	121, 778	13, 278	291, 084	34, 006
Worcester	1, 191	160	2, 806	295	3, 997	455
Total	577, 953	67, 517	504, 249	55, 496	1, 082, 202	123, 013

Summary of forest products by counties (1875)—Continued.

Articles and counties.	For sale.		For use.		Total.	
	Quantities.	Value.	Quantities.	Value.	Quantities.	Value.
MAPLE MOLASSES.	*Gallons.*		*Gallons.*		*Gallons.*	
Berkshire	3,138	3,754	4,793	5,584	7,931	9,338
Franklin	2,233	2,916	3,682	4,489	5,915	7,405
Hampden	652	616	1,319	1,366	1,971	1,982
Hampshire	2,132	2,130	1,911	2,010	4,043	4,140
Middlesex	10	15	23	29	33	44
Worcester	1,584	2,240	1,538	2,086	3,122	4,326
Total	9,749	11,671	13,266	15,564	23,015	27,235
LUMBER.						
Berkshire				94		7,142
Bristol						16,923
Essex				88		4,996
Franklin						4,413
Hampden				200		6,348
Hampshire						7,581
Middlesex						11,247
Norfolk						17,180
Plymouth						37,651
Worcester				49		62,226
Total				431		175,707
RAILROAD SLEEPERS.					*Number.*	
Berkshire					21,819	10,197
Bristol					4,497	2,172
Essex					200	100
Franklin					91,341	38,951
Hampden					82,287	36,332
Hampshire					66,176	29,190
Middlesex					52,544	24,736
Norfolk					12,615	5,751
Plymouth					750	280
Worcester					126,315	56,462
Total					458,544	204,171

General summary of certain manufactures at different periods.

	1845.	1855.	1865.	1875.
LUMBER.				
Number of establishments			1,137	579
Capital invested			$1,594,760	$2,719,711
Value of stock used				$2,123,563
Persons employed	2,506	3,413	1,980	1,961
Value of goods made	$921,106	$3,664,462	$3,824,754	$3,953,956
WOODEN GOODS.				
Number of establishments		109	487	460
Capital invested		$328,980	$1,585,870	$4,475,095
Value of stock used			$1,820,630	$3,627,888
Persons employed	1,592	1,822	2,688	4,267
Value of goods made	$964,833	$2,271,924	$3,387,538	$7,208,317
CARRIAGES AND WAGONS.				
Number of establishments	563	425	285	356
Capital invested	$553,434	$949,770	$1,106,938	$2,412,709
Value of stock used			$1,248,673	$2,099,173
Persons employed	1,881	2,491	1,941	2,073
Value of goods made	$1,343,576	$2,352,955	$2,427,777	$4,433,458
FURNITURE.				
Number of establishments	449	309	306	294
Capital invested	$477,374	$1,913,615	$1,853,403	$4,949,990
Value of stock used			$2,338,366	$3,799,379
Persons employed	2,594	4,243	4,097	6,674
Value of goods made	$1,476,679	$3,969,982	$4,989,891	$8,422,883

Summary of power used, and classification of persons employed, 1875.

Manufactures.	Steam-engines.		Water-wheels.		Persons employed.			
					All ages.		Under 15 years.	
	Number.	Horse-power.	Number.	Horse-power.	Males.	Females.	Males.	Females.
Lumber	102	7, 242	602	11, 866	1, 958	3	17	....
Wooden goods	82	5, 771	164	3, 751	4, 091	176	119	2
Carriages and wagons	30	1, 046	26	448	3, 018	54	2	....
Furniture	77	5, 426	110	2, 405	6, 014	660	39	91

Kinds of saws in lumber-mills, 1875.

Description of saws.	Number of saws.
Band	22
Circular	1, 782
Cylinder	45
Gang	3
Gig	41
Mulay	15
Up and down	240
Total	2, 148

Carriage and wagon manufacture in 1875, *by counties.*

Counties.	Number of establishments.	Capital invested.	Value of goods.
Barnstable	8	$6, 650	$7, 583
Berkshire	25	56, 250	101, 540
Bristol	26	164, 400	241, 605
Essex	92	868, 585	1, 934, 164
Franklin	10	30, 700	55, 099
Hampden	11	92, 400	177, 570
Hampshire	22	48, 850	100, 480
Middlesex	42	223, 440	306, 973
Nantucket	1	1, 000	2, 000
Norfolk	15	60, 625	121, 628
Plymouth	8	8, 700	22, 330
Suffolk	50	577, 555	833, 784
Worcester	46	273, 550	438, 702
Total	356	2, 412, 705	4, 343, 458

Furniture manufacture in 1875, *by counties.*

Counties.	Number of establishments.	Capital invested.	Value of goods.
Berkshire	5	$35, 300	$52, 500
Bristol	2	28, 500	23, 800
Essex	22	116, 600	193, 981
Franklin	18	180, 125	261, 982
Hampden	10	101, 600	167, 442
Hampshire	1	3, 500	3, 000
Middlesex	30	283, 300	960, 116
Norfolk	6	33, 000	51, 250
Plymouth	3	44, 000	63, 000
Suffolk	107	1, 655, 465	3, 551, 847
Worcester	90	2, 468, 600	3, 084, 965
Total	294	4, 949, 990	8, 413, 883

Lumber manufacture in 1875, *by counties.*

[Including clapboards, hoops, headings, laths, piles, planed lumber, sawed lumber, shingles, staves, shooks, &c.]

Counties.	Number of establishments.	Number of saws.	Capital invested.	Value of goods.
Barnstable	1	....	$5,000	$12,500
Berkshire	69	192	186,795	300,752
Bristol	37	114	68,262	143,879
Essex	19	117	329,117	389,507
Franklin	92	318	241,967	250,463
Hampden	54	127	167,068	407,696
Hampshire	58	172	183,357	376,002
Middlesex	44	187	337,307	476,106
Norfolk	5	19	11,334	27,556
Plymouth	87	202	205,500	295,580
Suffolk	7	....	562,600	498,900
Worcester	156	610	462,404	775,015
Total	629	2,058	2,760,711	3,953,956

Wooden goods manufactured, 1875, *by counties.*

[Includes artificial wood ornaments, baskets, basket rims, burnetized and kyanized wood, casks, kits and bungs, cask and basket hoops, clothes-driers, clothes-pins, excelsior fret-saw work, holly-wood work, kindlers, kindling-wood, lamp and cigar lighters and toothpicks, medicine-chests, lasts, doors, blinds and sash, paving-blocks, printers' fixtures, picture and looking-glass frames, pegwood and pegs, rattan, rattan-goods, razor-strop woods, saw-horses, spools, sieves and sieve-hoops, step and other ladders, veneers, wooden ware, wood-hangings, wood-pulp, wood moldings and scrolls, wood turned and sawed, wood carvings, wooden handles, willow ware, and rustic ornaments, &c.]

Counties.	Number of establishments.	Capital invested.	Value of goods.
Barnstable	9	$8,400	$17,750
Berkshire	12	21,700	75,564
Bristol	49	234,255	458,914
Essex	36	141,588	326,363
Franklin	20	265,850	121,332
Hampden	22	81,125	198,088
Hampshire	26	162,200	185,736
Middlesex	71	1,719,200	1,989,234
Norfolk	5	41,050	34,800
Plymouth	13	59,150	113,830
Suffolk	111	988,017	2,211,885
Worcester	86	752,560	1,474,821
Total	460	4,475,095	7,208,317

Miscellaneous manufactures, 1875.

Manufactures or industries.	Number of establishments.	Capital invested.	Value of goods.
Charcoal	4	$18,400	$22,000
Carpentry and joinery	1,042	1,851,956	8,012,265
Coopering	87	117,958	452,129
Kindling-wood making	7	4,400	10,200
Lumber sawing and dressing	26	61,880	41,243
Mast, spar, block, and pump making	14	17,088	32,765
Wheelwrighting	388	192,480	632,939
Wood carving, turning, &c	43	61,105	182,867

Ship-building.

Classification.	Number built.	Tonnage.	Value of hulls of vessels.	Total value with complete equipments.
BY COUNTIES.				
Barnstable	12	140	$11,075	$16,095
Bristol	2	522	26,000	49,000
Essex	50	15,042	858,750	1,167,900
Norfolk	1	2,100	115,000	140,000
Plymouth	3	1,111	60,500	80,000
Suffolk	34	26,320	1,408,376	1,709,000
KINDS OF VESSELS.				
Barges	2	350	3,500	....
Barks	13	10,720	562,065	740,065
Barkentines	3	1,565	77,000	112,000
Brig	1	330	13,000	20,000
Fishing-boat	1	....	....	100
Schooners	48	11,262	637,965	863,585
Ships	12	20,298	1,006,070	1,303,070
Sloop	1	101	8,500	10,500
Sloop-of-war	1	900	148,000	....
Steamboats	2	228	15,000	26,500
Steam revenue-cutter	1	294	....	73,000
Sail-boats	10	40	3,175	4,575
Yachts	7	47	5,426	8,600
Total	102	46,135	2,479,701	3,161,995

Value of insurable property, 1875.

Property.	Value of buildings.	Value of machinery.	Value of average stock on hand.
Carriages and wagons	$1,150,665	$218,913	$1,276,586
Furniture	1,809,540	854,565	2,430,532
Lumber	999,945	1,029,937	1,293,750
Wooden goods	1,541,195	929,491	1,767,136

Wages, 1875.

Manufactures and occupations.	Average yearly wages.				Total wages paid during year ending May 1, 1875.
	Both sexes, all ages.	Males above 15.	Females above 15.	Both sexes, under 15.	
Manufactures.					
Carriages and wagons	$622 04	$628 05	$289 08	$202 00	$1,867,982
Furniture	569 39	601 80	260 04	112 91	3,303,630
Lumber	432 08	434 78	85 00	163 64	718,987
Wooden goods	553 58	575 62	237 91	194 10	2,235,039
Occupations.					
Carpentery and joinery	658 63	658 63	....	....	3,165,514
Coopering	674 46	674 46	....	....	110,937
Wheelwrighting	594 91	594 91	....	....	161,817

Instruction in forest-culture recommended at the State Agricultural College at Amherst.

The executive committee of the Massachusetts Agricultural College (Amherst), in a report made in February, 1876, included the following recommendation, which, being fully discussed, was adopted:

It is also recommended that some instruction be given in forestry, both theoretically and practically, and that special attention be paid to the raising of forest trees from seed, their care and treatment in the nursery, their permanent planting in various portions of the farm, and the subsequent care of the plantations. The time is not far distant when every farmer in the country will, in his own interest, be obliged to give some attention to the subject of tree-planting, and such a course as is here recommended will be of advantage to the students and to the State at large. Similar considerations apply to the raising of fruit-trees. A nursery of reliable standard fruit-trees, adapted to one section, ought to be a source of some income to the institution.

Experiments upon the pressure and flow of Sap, at the Massachusetts State Agricultural College.

About 1720, the Rev. Stephen Hales, an English clergyman, began a series of experiments upon the pressure of sap, and the absorption of water by plants, carefully weighing, measuring, and publishing the results. These experiments have since been quoted by vegetable-physiologists, and have formed the basis of much that is known upon this subject, by leading to investigations and suggesting methods of research.

With the view of studying the laws that govern the flow of sap in our American forest trees, a series of experiments was begun, in the spring of 1873, at the Agricultural College at Amherst, by its president, Wm. S. Clark and associates, which have led to very interesting results. Several mercurial gauges were provided and attached to trees, which were tapped and connected, so that the pressure of the sap could be read upon a scale. Trees were tapped in great variety, and the facts noted concerning the flow of sap; but by far the most interesting results were obtained upon the sugar-maple and the black birch.

It has long been known that sap can be obtained from the sugar-maple, at any time between the fall of the leaves in autumn and the near approach of their return, whenever a bright warm day follows a freezing night. In fact sugar has been made from the maple in every month from October to May. It is also well known that the flow of sap in the sugar-season depends very much upon the meteorological conditions, and that the rate of flow changes in different hours of the day. The temperature must be above the freezing-point, and the preceding night should be below it. A bright warm day, with a west wind, following a night of severe frost, the ground being abundantly moist or still covered with snow, affords perhaps the best flow in the proper season. Freezing appears indispensable, and no maple-sugar can be made where there is no frost.

In the Amherst experiments it was found that the pressure was *inward* at some hours, and *outward* at others. From records running through two spring seasons (1873 and 1874), and from the detailed results, as published by President Clark,[1] we present the following:

We found that sap flowed from the heart-wood; that the flow was regular and long continued, but not so abundant as from sap-wood, and that by simply removing the bark, without wounding the wood, the sap flowed profusely, but stopped early. The surface flow, where the

[1] *Agriculture of Massachusetts*, 1873–'74, pp. 159–204, and the same for 1874–'75, pp. 204–312. These articles were also separately published.

bark had been removed 2 inches wide and 5 long, gave 12 pounds more sap than from the heart, but dried up 11 days sooner.

Birch sap in our climate yields grape-sugar in small quantities, and the sap of the vine, mucilage or gum. In Northern Europe, a sweet sirup is made from birch sap. Cane-sugar is yielded by the maples, walnuts, and hickories, but from the first only, in profitable quantities. All of these carbo-hydrates appear to be formed from starch stored up by previous growth in the roots and trunk.

A tree tapped on the north side yielded daily twice as much as from the south, and flowed two weeks longer.[1] The sap flows most freely within 12 feet of the ground, and diminishes rapidly above this point. Sap flows from both ends of a cut root, and both contain sugar. The annual tapping of a maple for many years does not appear to injure it perceptibly in growth.

The annual average yield of maples is about 60 pounds of sap or 2 pounds of sugar.[2] Two spouts will yield more than one, but not twice as much, and by still further increasing the number a greater quantity is obtained, but in diminishing degree.

At certain hours, and on some entire days, the pressure on the gauges showed *suction*, or *absorption*, and whenever the sap flowed they indicated an *outward* pressure. The range and flow were much greater on the birch than on the maple. These results can best be shown by the following tables:

I.—*Flow of sap from certain trees, as observed in the spring of* 1874, *at Amherst, Mass.*

Trees, &c.	Period observed.			No. of days on which sap flowed.	Greatest flow in one day.		Total flow (pounds).
	Beginning.	Ending.	No. of days.		Pounds.	Date.	
Acer Pennsylvanicum	Mar. 23	May 4	41	37	1. 62	Apr. 19	16. 31
Acer saccharinum	Apr. 1	Apr. 28	28	18	8. 50	Apr. 8	55. 69
Betula alba, var. *populifolia*	Mar. 23	May 22	41	37	10. 75	Apr. 11	174. 38
Betula lutea (1)	Mar. 29	May 26	59	51′	22. 12	Apr. 17-20	397. 50
Betula lutea (2)	Apr. 3	May 26	53	51	54. 26	Apr. 21	929. 50
Betula papyracea	Mar. 29	May 26	59	54	63. 25	May 5	1, 485. 37
Carpinus Americana	Apr. 9	May 22	44	16	1. 56	May 17	6. 81
Juglans cinerea	Mar. 23	May 18	55	40	1. 62	Mar. 26	18. 81
Ostrya Virginica	Apr. 16	May 26	41	33	27. 12	May 17	286. 06
Vitis æstivalis	May 11	June 3	24	22	2. 37	May 17	14. 56

In the above observations the *Acers* and *Juglans* were notably early, and the *Ostrya*, *Carpinus*, and *Vitis*, late, in flowing, while the *Betulas* had a somewhat uniform flow through the season.

[1] We are unwilling to accept this as a rule, and are inclined to regard it as an exception. Very much depends upon whether the spout is inserted over or into a strong vigorous root, and whether upon a side where the roots have a full supply of water or grow in a dry soil. The leaning side of a tree is generally regarded as best for tapping, but we are not aware that it has been proved by experiments.

[2] A tree is mentioned in Leverett, Mass., that yielded 1,400 pounds of sap, or about 14 pounds of sugar in a season. The yield varies considerably one year with another, and in some soils and aspects more can be made than in others.

II.—*Fluctuations in mercurial gauges, Amherst, Mass.*, 1874.

Trees, &c.	Height (ft).	Girth (ft.)	Period observed.		Highest.		Lowest.		Range: Inches of mercury.
			Beginning—	Ending—	Inches.	Date.	Inches.	Date.	
Acer rubrum	40	2.5	Mar. 28	Apr. 24	16.4	Apr. 8	— 1.4	Apr. 10	17.8
Acer saccharinum (1)	60	6.3	Mar. 21	June 2	35.0	Mar. 28	—11.7	Apr. 7	46.7
Acer saccharinum (2)	60	6.3	Mar. 21	May 1	32.0	Mar. 28	— 6.8	Apr. 4	38.8
Acer saccharinum (3)	60	6.3	Mar. 21	May 14	4.0	Apr. 6	— 7.0	May 3, 4	11.0
Acer saccharinum (4)	60	6.3	Mar. 21	June 2	19.7	Mar. 28	— 5.3	Mar. 22	25.0
Acer saccharinum (5)	60	6.3	Mar. 21	June 2	46.0	Apr 2	—23.0	Mar. 31	69.0
Betula alba, var. *populifolia*	30	1.3	Apr. 9	June 30	35.0	Apr. 23	—17.0	May 10	52.0
Betula alba, var. *populifolia* (root)	35	1.7	Apr. 12	Sept. 14	33.6	May 12	—20.2	Aug. 26	53.8
Betula lutea (root)	65	3.8	Apr. 23	June 30	68.0	May 10	+ 4.4	Apr. 26	63.6
Betula lutea (upper gauge)	60	3.7	Apr. 24	May 21	36.8	Apr. 24	— 9.3	Apr. 28	46.1
Betula lutea (lower gauge)	60	3.7	Apr. 9	June 30	65.5	Apr. 22	—18.5	May 19	84.0
Betula papyracea	60	3.7	May 3	June 30	54.0	May 6	— 7.0	June 14	61.0
Juglans cinerea	......	......	Mar. 28	Apr. 22	10.8	Apr. 14	— 0.7	Apr. 10	11.5
Ostrya Virginica	45	2.83	Apr. 9	June 6	35.6	May 13	—21.7	May 19	57.3
Pyrus malus (root)	35	2.7	May 15	June 30	13.3	May 31	— 1.4	May 15	14.7
Vitis æstivalis (upper gauge)	50	1.0	May 12	Aug. 17	35.0	May 13	— 6.3	Aug 17	41.3
Vitis æstivalis (lower gauge)	50	1.0	May 7	Aug. 17	74.0	May 26	—12.7	June 29	86.7
Vitis æstivalis (root)	40	0.8	May 2	Sept. 14	78.3	May 29	— 4.0	May 2	82.3

Gauge No. 1, of sugar-maple, was inserted into sap-wood about 2 feet from the ground; holes 1 inch and 2 inches deep.

Gauge No. 2 was connected by a stout rubber hose with a root 1 inch in diameter, washed bare, to prevent wounding of fibers. It was cut open at 2 feet from the tree and the gauge connected with the stump, which was attached to the trunk.

Gauge No. 3 was attached in the same way to a detached root still remaining in the soil.

Gauge No. 4 was attached to a gas-pipe screwed 10 inches into the tree, admitting no sap except from near the center of heart-wood.

Gauge No. 5 was attached to the sap-wood, among the branches, at an elevation of 20 feet above No. 1.

The upper gauges of the yellow birch and vine were 30 feet above the lower ones.

III. *Water-gauges, showing absorption or flow of sap in detached roots of trees; Amherst, Mass.*, 1874.

[The inches in the following table are those of columns of water in vertical tubes, 36 inches, weighing one ounce.]

		Acer saccharinun.	Pyrus malus.	Castanea verca.	Ulmus Americana.	Quercus alba.[2]	Fraxinus Americana.
Water-gauge attached		May 1	April 11	April 11	April 11	April 11	April 11
Maximum absorption	inches	— 69.0	— 25.0	— 8.0	— 26.5	— 46.0	— 5.0
	ounces	1.91	0.69	0.22	0.74	1.28	0.14
Water-gauge attached		May 10	April 16	April 15	April 15	May 2	April 15
Minimum absorption	inches	— 2	+ 22	+ 0.5	+ 12.5	+ 2.5	— 0.3
	ounces	0.055	0.188	0.014	0.34	0.07	0.006
Water-gauge attached		June 1	May 16	....	April 29	May 26	May 22
Total absorption	inches	410.7[1]	176.3	80.4	155.0	759.1	607.0
	ounces	11.4[1]	4.89	2.23	4.30	21.09	16.88
Total flow	inches	0.0	351.7	1.0	256.8	3.5	0.0
	ounces	0.0	9.77	0.03	7.13	0.97	0.0
End of observations		June 3	June 30	June 3	June 30	June 3	June 3

[1] In month of May.

[2] The tube was often emptied within an hour or two after it was filled, so rapid was the absorption.

Experiments in tree-planting by Mr. Joseph S. Fay, at Wood's Holl, Barnstable County, Mass.

At the close of the season of 1875, the plantation of Mr. Fay included something over 125 acres, of which about 100 were sown broadcast, chiefly in the spring, and about 25 were set with imported trees. The seed sown were chiefly those of the native pitch-pine, with some white pine, the Austrian, Scotch, and Corsican pine, the Norway spruce, and the European larch. The imported trees number about 35,000, consist-

ing of the Austrian, Scotch, and Corsican pines, Norway spruce, Norway maple, English sycamore (*Acer pseudo-platanus*), English oak, alder, Scotch birch and larch, wych elm and Huntington and red Germain willows. There were also set several thousand native pines from the eastern part of Falmouth.

This plantation is between Buzzard's Bay on the west and north, and Martha's Vineyard Sound on the east and south, the highest elevation being about 150 feet above the sea. The surface is uneven and made up of abrupt hills and deep hollows, sprinkled over with bowlders of granite, and the soil a drift formation of clay and gravel with a yellow or sandy loam. It was, before seeding, an old pasture ground, with no tree except an oak, that springs out of the huckleberry bushes here and there, but hardly rising above them on account of the wind, and from being kept down by browsing. The annual rain-fall in this section is about 45 inches, and the prevailing winds in summer are southerly, and in winter northerly.

The native pines of Mr. Fay's plantation were set in 1853–1856, and imported trees were set in 1852, 1853, 1855, 1871, and 1872. Native pine seeds were sown in 1858, 1861, 1864, and 1868. The foreign seeds were sown in 1861, 1862, 1868. The results are stated as follows:[1]

The Scotch pine from the seed have proved on the whole, including prompt germination, the best grower and very hardy; but the weevil affects the symetry of many trees. The Norway spruce and English oak have done well, and the white pine; but all three suffer when much exposed, as on the outside of a plantation, to the strong salt winds. The Austrian pine does well, but is slow and irregular in germinating, and makes a later start from the seed. The larch has not come well from the seed; from the nursery or as imported it does remarkably well; so with the Scotch birch and alder. The Scotch pine does finely from the seed or the nursery, and from the latter the English sycamore does well. All have done better than the native pitch-pine.

One kind of pine, though not fully tested by me, promises better than the rest, namely, the Corsican (*Pinus laricio*). In my first importation I ordered five hundred, but when transplanted in my absence they were mixed with the Austrian, and I lost sight of them for ten years. I was then so struck with their great vigor, beauty, and fine promise, that in 1868 I imported some seed and commenced sowing them, mixed with other kinds, upon vacant lands, and have since kept it up. Some of those that came up are very strong and healthy, while others are affected by some insect or a kind of blight. They are very hardy and beautiful when not so affected. I think that some of the nurserymen have imported and sell them under the name of Austrian. Of those sown in 1868 some are (in 1875) over eight feet high, of which nearly or quite five feet grew in the last three years. At an early day I tried some seed of the French maritime pine (*Pinus pinaster maratima*) which were so successfully planted on the west coast of France under the first Napoleon; but, after germinating and growing thriftily to the height of six feet, they were winter-killed. This was the experience on Nantucket and Martha's Vineyard Islands, where they were tried extensively.

Some of the Scotch and Austrian pines, Norway spruces, and Scotch larches which I obtained from my brother, Mr. Richard S. Fay, of Lynn, in 1853, probably imported by him in 1850, are about 40 feet high, and from 10 to 14 inches in diameter one foot from the ground. Some native white pines set out about the same time have done as well. Of those imported in 1853, many are about 35 feet high, and 8 to 12 inches in diameter one foot from the ground. Of the Scotch pines from seed sown in 1861, some, favorably situated—that is, not crowded and in fair soil and shelter—are 30 feet high and 10 inches through the butt a foot from the ground. Most of them were not too thickly sown in 1862 and 1863, are upwards of 20 feet high, and 6 inches in diameter one foot from the ground.

All the pines have done well from the seed, on the whole, except the native pitch-pines, which became sickly, and which, after a good growth to a certain point, I am cutting out for fuel, as not worth keeping. Some, however, that I transplanted in 1853, 1854, 1855, are very strong and healthy, being at least 30 feet high and 10 to 12 inches in diameter. I am told that the seedling native trees, of which many acres have been planted on Nantucket, are proving worthless and are being cut down.

My first importations of trees were in 1871 and 1872, and consisted of English alder, Scotch birch, Scotch larch, English sycamore, Norway spruce, and Austrian, Scotch,

[1] *Massachusetts Ploughman*, February 26, 1876, in answer to inquiries by Prof. C. S. Sargent.

and Corsican pines. The alder I have found to be a rapid grower, very hardy and ornamental, well adapted for a screen or a shelter to other trees. Some, which were set out at 1½ to 2 feet high in 1871, are now 8 and 10 feet high. The birches have done well, and so with the pines; the sycamore and Norway spruce not as well, needing, perhaps, two years on the nursery or a better soil. The Scotch larches were heated on the voyage, and, the summer following being very dry, many died. Those that survived have recovered, and, being now finely started, are making a vigorous growth.

My first purchases of foreign trees were planted about my house, in the openings of a thirty-acre lot of oak and beech woods near by, and on the bare gravelly hills overlooking the Sound and raked by strong winds. The trees I imported in 1853, after two years in the nursery, I planted out, some in clumps of a quarter and half an acre each, on an old pasture which I did not "seed down," and which had not a tree upon it. I surrounded them with fences of wire drawn through cedar posts to keep off the cattle, who find in them a grateful shade, now the trees are too large to be injured by them. Others I placed along the walls of my cultivated fields, and some on the margin of my old deciduous woods, so as to afford a shelter and a variety of foliage. My importations of 1871 and 1872 were planted as soon as received on an old and poor pasture-land, where I intended they should remain. My method was to run with oxen deep single furrows 7 feet apart, and then set the trees in them 7 feet from each other. The land is rough and of the average soil of a worn-out pasture. These have done well, except those larches which died, as before stated, in consequence of being heated on the voyage, taking into the account the saving of labor and the use of more valuable land, by not putting them into a nursery, though if placed there at the first start they may have seemed to do better.

The trees were introduced as a matter of taste, and as an experiment, without the calculation of any immediate advantage. Still, I think if it had been near a market, or one had been sought, there would have been a profit in the sale of the surplus young trees, and now already in the sales of wood, if only the thinnings. The land has been, no doubt, improved by the deposit of thousands of loads of leaves upon it and by the shade afforded it, while it has been lightened and lifted by the permeation of the roots of the trees. Much of the labor has been done at intervals of farm-work, and chiefly without professional supervision.

When I bought my place in the fall of 1850, except a few stinted red cedars on Parker's Point, and some white cedars in the swamps, there was not an evergreen tree within three miles of my house, and hardly any tree of any kind in sight of it. The woods (oak, beech, and hickory) were in the dells and valleys behind the hills fronting the sea, and it was maintained that trees would not grow and could not be made to do so in the face of the salt-laden winds from the south and southwest. The exposure was certainly great and the soil poor, and trees planted singly or sparsely, perhaps, could not have resisted it, but close planting made a shelter, and those not specially from an inland habitat (like the white maple) have done well, and seem to the manor born.

In answer to the question, "If you were to do the work over again, could you improve on the methods employed by you?" Mr. Fay replied:

I think I should recommend, where the ground was not too stony and rough, instead of sowing seed broadcast, to run parallel furrows, not deep, running east and west (so the mid-day sun will not strike across them) seven feet apart, and drop the seeds in them, merely pressing them into the ground, and not covering them more than this, if at all. This, in the first place, especially on a hill-side where the furrows should be run at right angles with the slope and not vertically, will prevent the seed from washing down to the low places; in the second place, the seed will be likely to come up more at the same time, and would be more uniformly distributed than can be done broadcost, unless sowed when there is snow on the ground, and also less seed would be required and less would be wasted; in the third place, the side of the furrow would tend to shade the young germ, which, on the open sward, in a dry time, is apt to be withered and destroyed by the heat. In my plantings, where the trees have come up too thickly, I have transplanted them to spots where the seed has failed or was not sown, but this makes extra labor. If sowed in furrows, the seed might be dropped at intervals of four or five feet, and even then, in a few years, if all were to come up they would require thinning. In this case, the surplus could be sold or planted elsewhere. They would make good nursery plants.

As to imported trees, when it is considered that the average cost, landed at the farm, of English-grown plants one or two feet high, is less than one cent each, it would be a saving of time to procure them and set them out in the place where they are to grow. There is a little uncertainty in their condition, but, as a rule, they come in good order. My first importations I put in the nursery for two years and then set them out. This requires two plantings. My last I placed, as I have stated, in the field where they were to grow, in parallel furrows. I think it would be better to plow cross furrows the same distance apart, or say 10 feet each way, and plant the trees at

the intersection. Unless the land is very much exposed to the wind, 10 feet is near enough, as even then, in about seven years, a man could hardly walk between the rows. If there are bleak hills to be planted, then the trees should be nearer together say 6 or 7 feet, so as to shelter each other more; but, when they get up and are doing well, they ought to be thinned. But for this need of shelter in exposed places they would do better in view of a 25-years' growth to be 20 feet apart each way. Up to a certain point they help each other by proximity, but it takes great courage to cut down strong and thrifty trees to make room. Yet on a farm the thinnings may be useful, and when near large towns, would be salable for cheap rustic fences and inclosures, and certainly for kindling stuff. It is also to be considered that if planted too far apart, the growth would be more lateral than vertical in proportion, and the trees would be more spreading, and tend less to taper form and slenderness.

In planting out at once on rough land instead of first in a nursery, though the trees may take a year or two to get a start, for the roots to find their way into the closer soil of an old field, there is a great saving of labor and not *much* loss of time, as each transplanting checks a tree in its growth. One thousand trees will cover an acre well, if planted six or seven feet apart, and five hundred, if nine or ten feet from each other, and after the furrows are made two active, handy men could plant one to two acres a day. Care should be taken not to plant too near other older trees, lest they overshadow and kill out the new planting, or the overhanging limbs chafe and keep down the leading shoots. I have wasted a great many trees by planting them in the old woods where the spaces seemed large and open, by their being overgrown and shaded out. If I were again to set out young trees among the old woods, I should cut the latter all down clean, and let them start again from the stumps with the new planting. If this is not done, and it is desirable to keep the old trees, they must then be carefully watched and trimmed and lopped, as the young ones grow up under and about them. And I have lost many trees by their being planted or sowed too near each other. When trees are two or three feet high, it seems quite safe to plant them five feet apart, but soon they are too close, and the most vigorous crowd out and destroy the weaker. In my seeded plantations in many spots, they have come up at the rate of 40,000 trees to the acre; hence my advice to mark off the fields in furrows and sow in them rather broadcast. It would be a great saving every way, except in a little labor at the start. Nor in sowing should I now mix the seeds of different pines, as I have done, but sow each kind by itself distinctly. For as a Scotch, for instance, comes up promptly, it is likely to get the start of the Austrian, the seed of which sometimes lies dormant two or three years, and so overshadows and crowds it out. If the latter were sowed by itself, though it would be slower in germinating, all would be likely to start together, and when fairly rooted make up for lost time. It would not be amiss to plant here and there some desirable kinds of acorns or nuts, for while the pines would grow faster and keep them down, if for any reason the pines were cut off, the oaks and hickory would come forward very rapidly when open to the sun. A few chestnuts that I have planted under the lee of other trees, have made an extraordinary growth, and in the interior, their habitat, they must be a very profitable tree to plant.

You will bear in mind that I have given you my experience as a planter of trees, much as an incident of farming and not as a business. Were it taken up as a thing of itself then it might be advisable to start seed-beds and raise one's own trees, and nurse them, instead of importing them. I have endeavored to raise a forest about me at the least possible cost of labor, and not looking much to the hurrying of the result or to count up an early profit. The land was denuded, and exhausted, and moss-grown, and I took this method to cover it with verdure and restore it, believing that the wood would compensate me or my heirs sooner or later. * * * In closing my discursive remarks, I would say that, considering the position of my place, exposed on the northwest to the violent winds of winter sweeping across Buzzard's Bay, and in summer to the strong breezes from the southwest, bringing salt spray from Vineyard Sound, the vigorous growth and promising appearance of my forest plantations is very encouraging to those more favorably placed. Not only may the destruction of our forests be partially remedied at a cheap cost, but the waste and sterility of our land by long cultivating and pasturing, be removed and replaced with fertility by the simple process of nature. It is much, also, to restore shade in summer and shelter in winter by the renewal of our forests.

Mr. Fay, in writing in August, 1877, says: "I have this spring planted out 3,000 of seedling larches, obtained of Robert Douglas and Sons, of Waukegan, Ill., which promise as well as the foreign ones. Mr. Henry Coffin, of Nantucket, has planted 30,000 of the same this last spring, which are doing well." He mentions the red or slippery elm, the catalpa, yellow locust, American elm, sugar-maple, varieties of the spruce, English sycamore, Norway maple, and Linden, as cultivated with success in his vicinity. The Scotch elm did not grow well, perhaps

from want of better soil. The native pitch-pine, though a prevalent tree, seemed to suffer in some places from a disease or an insect. It is a local trouble, and may be caused by some defect in the soil, perhaps because not sandy enough. In speaking of seed sown broadcast upon sward land, he had noticed that in dry seasons the seed would not come up as well by this method, and adds: "Experience shows that where the ground is suitable, it is better to plow furrows, that is, single furrows at suitable intervals, say four or five feet apart, and drop the seeds in them, covering lightly. If the land is too rough for a plow, then make holes with a hoe at regular intervals, and drop the seed and cover lightly."

Several hundred acres of the native pitch-pine had been planted in his vicinity to improve the land and for fuel.

BRISTOL COUNTY.—Mr. Morrill Allen, of Pembroke, Mass., in a letter relating to tree-planting, written December, 1847, says:[1]

A man in Bristol County about fifty years ago planted a field somewhat exhausted with acorns; when the young trees were two or three inches high he plowed and hoed as in a field of Indian corn; the trees grew, to the astonishment of the whole neighborhood, and in less than forty years were ripe for the ax. About a century since there was an experiment in this town in planting the white oak for ship-timber, the success of which ought to have encouraged frequent repetition. The grove was in cutting for timber thirty years since, and a man between seventy and eighty years old told me that in his boyhood he assisted in planting these trees. It is not to the existing generation so helpless an undertaking as some would represent it, to plant forest-trees, even those of slow growth. I recollect measuring the circumference of an oak tree in West Newbury, the acorn of which was planted by Benjamin Poore, who is yet comparatively a young man, and I think it measured 27 inches. It is a well proportioned, handsome tree. Had he planted at the same time fifteen acres of similar soil it would have become before now an inexhaustible wood-lot for the use of one family.

The general elevation of this district above sea-level is about 80 feet; highest point 210; prevailing winds southwest, and rain-fall 46 inches. The native timber consisted of several species of oak, the walnut, maple, pine, and hemlock, used for lumber A variety of trees for fuel and cabinet-work are found in the forests. There has been but little clearing within the last century; the woods have simply been cut off and allowed to grow again. In a few cases forest-planting has been done on a small scale, but so recently that no result has been reached, though the plantings are usually in a healthy condition. Fires set by locomotives, or by careless persons, sometimes do a great deal of damage.—(*Elisha Slade*, Somerset, Bristol County, Mass.)

Having been, for thirty years past, more or less engaged in buying woodland and cutting it off, I wish to state that I know, from careful observation, that an acre of good land, where there is a mixture of the several kinds of oak and walnut (hickory), cut off while young and thrifty, will produce, during the first 20 or 25 years, a cord of wood yearly. I believe that most kinds of hard wood are worth 20 or 30 per cent. more, for fuel, at the age of 25 years than at 75.—(*A. M. Ide*, of South Attleborough, to George B. Emerson: *Trees of Massachusetts*, p. 26.)

ESSEX COUNTY.—Mr. Richard S. Fay commenced, in 1846, planting on his estate near Lynn, in Essex County, and in that and the two succeeding years, planted 200,000 imported trees, to which were afterward added nearly as many more, raised directly from the seed, nearly 200 acres being covered in all. The sites of these plantations were stony hillsides, fully exposed to the wind, destitute of loam, their only covering a few straggling barberry bushes and junipers, with an abundant undergrowth of woad-wax (*Genista tinctoria, L.*), always a certain indication in Essex County of sterile soil. He employed in his plantations oaks, ashes, maples, the Norway spruce, Scotch and Austrian pines; but the principal tree planted was the European larch. No labor was expended on the land previous to planting, the trees, about one foot high, being simply inserted with a spade, and no protection has at any time been given them, save against fire and browsing animals. I recently visited these plantations, twenty-nine years after their formation, and took occasion to measure several of the trees, but more especially the larches. Some of these are now over 50 feet in height, and 15

[1] *Transactions of the Agricultural Societies of Massachusetts*, 1847, p. 45.

inches in diameter 3 feet from the ground, and the average of many trees examined is over 40 feet in height and 12 inches in diameter. The broad-leaved trees have also made a most satisfactory growth, and many of them, on the margins of the plantations, are fully 40 feet high. During the past 10 years about 700 cords of fire-wood have been cut from these plantations, besides all the fencing required for a large estate. Fire-wood, fence-posts, and railroad-sleepers, to the value of thousands of dollars, could be cut to-day, to the great advantage of the remaining trees. The profit of such an operation is apparent, especially when we consider that the land used for these plantations did not cost more than $10 an acre, and probably not half that amount. (*Prof. C. S. Sargent*, director of the botanical garden and arboretum of Harvard College. *Agriculture of Massachusetts*, 1875–'76, p. 260.)

NANTUCKET COUNTY.—This island was originally timbered with oak, &c., but was entirely cleared off long ago. The temperature is some 10° to 12° cooler in summer than at Boston, and about as much warmer in winter. It is exposed to heavy winds, and therefore trees must be set close together to shelter one another. Some 20 or 30 years ago about 800 acres were planted in common pitch-pine, from seed. Much loss occurred among them a year ago, from a very warm time in February, which started vegetation, and heavy frosts in March and April, which did most harm in the warmer and more sheltered places.

In the town, which is closely settled, the elm, ailanthus, maple, European sycamore, willow, and ash grow well. There are 10,000 acres of wild lands on the island, suitable for timber culture, that can be had at $5 to $10 the acre. In the spring of 1877 Mr. Henry Coffin planted 30,000 European larch trees of one and two years' growth from the Douglas nursery at Waukegan, Ill., which are nearly all doing well. He also planted 10,000 European fir-trees which were injured on the voyage, so that some were mouldy, and about one quarter are dead. A thousand larch trees set the year before, have had two years' growth, and look well; they are set four feet apart, with a two-handed dibble, one man making the holes along the line, while the other follows, setting the trees and pressing the earth well down. They are set on light sward, on sandy soil, and in wild land. (Letter of H. C., November 26, 1877.)

Experience of Mr. George B. Emerson.

SUFFOLK COUNTY.—I have been cultivating without special care for more than twenty years, on land excessively poor, and exposed to all the winds, a few rods from Boston Bay, all the varieties of the English oak, beech, birch, linden, maple, elm, ash, mountain ash, and pine, and find them more hardy than the corresponding American trees, with a single exception. Our canoe-birch grows equally well with the beautiful European birch (*Betula alba*). Our hardiest oaks, the red, the black, and the pin-oak, in the same situation, do not do so well as the English. Our white maple alone, does as well as the two best European, the sycamore (*Acer pseudo-platanus*), and the Norway (*Acer platanoides*). Our best maple, the rock-maple, can with difficulty be made to live in the same situation. The English pine, or Scotch pine (*Pinus sylvestris*), does much better than our white pine (*Pinus strobus*), our pitch-pine (*Pinus rigida*), or our red pine (*Pinus resinosa*), all of which have the reputation of being hardy trees. (*George B. Emerson*, in preface to the second edition of his *Trees and Shrubs of Massachusetts*, p. xiv.)

A row of the *Ulmus campestris*, planted by Major Paddock, a carriage-builder by trade, was planted in front of the Granary burying-ground in Boston, about 1762, from a nursery in Milton. In 1860, one of these measured 12 feet 8 inches around at 3 feet from the ground.

Several trees in Brookline, which were planted in 1805, when they might have been 10 years old, are now (1875) 80 feet high, and average from 8 feet to 8 feet 6 inches in circumference at 3 feet from the ground. It would, from these examples, seem that the European elm not only grows rapidly in the eastern part of the State, but promises to attain its largest dimensions and full span of life. I have been unable to compare satisfactorily the rapidity of its growth with that of the American elm, but probably in its best condition the latter is of far more rapid growth, although in the ordinary

situations where the elm is planted, and where it generally suffers from insufficiency of root moisture, the European elm is immeasurably its superior in rapidity of growth, length of life, and general thriftiness. The fact that the European is fully a month longer in leaf than the American elm, that its tougher leaves would seem to offer a less appetizing food to the canker-worm, the greatest enemy of the American elm in New England, and its adaptability to all situations, are strong arguments in favor of giving the preference to the former for general cultivation.

Its thriftiness in smoky situations makes the European elm the most valuable tree our climate will allow for city street and square planting, and as a shade-tree by road-sides, no American tree is its equal.

The economic value of the wood of the European, which is hard and fine, has always been generally acknowledged to be superior to that of the American elm, and in Europe it is devoted to many important uses. For the hubs of carriage-wheels it is used almost to the exclusion of all other wood. If employed in situations where it is constantly under water, or kept perfectly dry, it excels almost every other wood in durability. It is considered the best timber for ships' keels. It is largely used for ships' blocks, and for pumps, piles, and water-pipes, and by the turner and cabinet-maker; and by the coffin-maker it is preferred to all other woods. The general cultivation of the European elm would add a valuable timber-tree to the products of Massachusetts.[1]

RHODE ISLAND.

Some statistics of timber and wood were reported from several of the towns in the State census of 1865; but they were not only incomplete, but incomparable, the amount of timber being in some cases expressed in feet and in others in value. The wood was in some towns also reported by quantity and in others by value. The census of 1875 shows a great improvement at many points, and among others in its classification of the land and its products. The following statement presents the totals by counties, of total areas, and of woodlands and lands not improved, from which we have deduced the percentages which these data afford:

Actual and relative amount of woodlands and value of forest products in 1875.

Counties.	Total acres.	Acres of woodlands.	Acres unimproved, not woodland.	Percentage of total acres.		Value of forest products, year ending June 1, 1875.
				Woodland.	Unimproved, not woodland.	
Bristol	11, 280	1, 567	361	13. 9	3. 2	$2, 217
Kent	79, 348	28, 560	7, 184	35. 9	9. 1	52, 469
Newport	54, 921	7, 476	2, 376	13. 5	4. 3	25, 041
Providence	180, 255	71, 780	4, 345	39. 8	2. 4	126, 737
Washington	155, 124	47, 071	10, 015	33. 4	6. 4	40, 602
Total	480, 928	156, 454	24, 281	32. 5	5. 05	[1]247, 066

[1] The value of farm products for the same year amounted to $4,781,263.

The State had 81 lumber-mills, the real estate of which was valued at $90,450, and the machinery, &c., at $37,855. They employed 123 men, whose wages amounted to $27,886, and from $71,430 worth of raw materials produced lumber valued at $163,710. It will be inferred from these returns that this industry is comparatively unimportant, and that the mills are mostly of small extent. Of the whole number 63 were driven by water-power, and probably were run but a part of the year.

[1] *Agriculture of Massachusetts*, 1875–'76, p. 272.

Amount of lumber inspected at Providence, R. I., since 1846.

Years.	Feet.	Years.	Feet.	Years.	Feet.
1846	7, 773, 903	1857	25, 536, 435	1868	29, 297, 902
1847	25, 996, 650	1858	20, 081, 668	1869	38, 445, 218
1848	31, 624, 444	1859	25, 159, 503	1870	41, 673, 300
1849	32, 682, 595	1860	25, 159, 503	1871	43, 979, 370
1850	18, 278, 052	1861	28, 100, 956	1872	46, 219, 917
1851	24, 484, 219	1862	13, 676, 893	1873	51, 262, 059
1852	24, 524, 070	1863	16, 256, 313	1874	42, 045, 894
1853	27, 703, 050	1864	20, 587, 198	1875	26, 932, 190
1854	24, 752, 184	1865	19, 220, 300	1876	26, 829, 713
1855	28, 614, 359	1866	28, 655, 184		
1856	33, 582, 307	1867	35, 222, 283	Total	884, 559, 643

NEW YORK.

The first attempt to procure statistics relating to forest products in this State is found in a circular letter addressed in 1791 by the Society for the Promotion of Agriculture, Arts, and Manufactures to the friends and promoters of rural economy. Among other queries were the following:

8. *Forest trees.*—Do you know any facts concerning the propagation of the locust tree? What can be done toward introducing the white mulberry tree? In parts of the country where wood grows scarce, would it be proper and profitable to raise in nurseries and transplant hickory, chestnut, beech, ash, and other trees for fencing and fuel? Or would it be advisable to make hedges of whitethorn, prim holly, yew, or other shrubs?—and cultivate peat and turf for making fires?

No general results followed these inquiries, and no statistics were obtained under State authority before 1855. The national census of 1850, and since, has reported the acres improved and unimproved, the general results of State and general census returns in this particular having been as follows:

Land in farms.

Years.	Acres improved.	Acres unimproved.	Total of preceding.	Acres not reported.[1]
1850	12, 408, 964	6, 710, 120	19, 119, 084	10, 960, 916
1855	13, 657, 490	13, 100, 692	26, 758, 182	3, 321, 818
1860	14, 376, 367	6, 616, 553	20, 992, 920	9, 087, 080
1865	14, 827, 437	10, 411, 863	25, 239, 300	4, 841, 700
1870	15, 627, 206	[2]6, 563, 604	22, 190, 810	7, 889, 190
1875	15, 867, 935	9, 779, 098	25, 647, 033	5, 432, 967

[1] Assuming the area of the State to be 47,000 square miles, or 30,080,000 acres.
[2] Of this, 5,679,870 is reported as woodland, and the rest as "other unimproved."

The total area of the State, according to Burr's Atlas, is 28,297,142 acres; and in 1875, 27,850,625 acres (exclusive of New York and Kings Counties) were assessed. The areas of cities, villages, &c., and a large amount of wild lands not in farms, are omitted from the census, and this will account for the discrepancies above given.

In 1875, for the first time, an effort was made to obtain statistics of the timber lands of the State, with the result shown in the following table:[1]

[1] The instructions directed enumerators to report as "improved lands" all land under cultivation or improvement, including pasture, meadow, arable land, and, in short, everything that had been reclaimed from a state of nature, deducting highways, lakes, and ponds of water, when the latter exceeded ten acres. "Unimproved lands" were defined as woodlands, swamps, marshes, and other vacant lands, including wild lands, where information could be procured. With reference to woodlands, the instructions were as follows:

"The acres in this column will form a *part* or *the whole* of those embraced in the preceding column as 'acres unimproved.' You should enter here the amount of *timber land;* that is, land covered with trees suitable for sawing into timber, or hewing into

Acres of improved and unimproved land in the State of New York, as shown by the census of 1875.

Counties.	Acres of improved land.	Acres of unimproved land.		
		In wood and timber land.	Waste lands.	Total unimproved.
Albany	248, 102	43, 796	16, 766	60, 562
Allegany	374, 332	211, 021	42, 156	253, 177
Broome	271, 933	125, 155	25, 581	150, 736
Cattaraugus	380, 681	313, 875	49, 280	363, 155
Cayuga	336, 165	59, 667	22, 373	82, 040
Chautauqua	432, 964	162, 749	21, 972	184, 721
Chemung	139, 171	53, 312	31, 092	84, 404
Chenango	396, 355	123, 633	14, 812	138, 445
Clinton	237, 524	187, 285	103, 417	290, 702
Columbia	315, 112	50, 319,	11, 786	62, 105
Cortland	218, 736	69, 871	7, 879	77, 750
Delaware	452, 785	295, 668	92, 781	388, 449
Dutchess	373, 477	65, 651	33, 005	98, 656
Erie	458, 343	100, 420	32, 235	132, 655
Essex	204, 215	180, 783	227, 192	407, 975
Franklin	214, 571	178, 281	514, 724	693, 005
Fulton	140, 460	87, 374	45, 853	133, 227
Genesee	238, 030	43, 763	11, 190	54, 953
Greene	235, 756	111, 873	31, 630	143, 503
Hamilton	24, 332	169, 316	382, 514	551, 830
Herkimer	297, 190	85, 218	47, 522	132, 740
Jefferson	556, 616	133, 703	66, 307	200, 010
Kings	9, 110	606	1, 374	1, 980
Lewis	241, 091	249, 045	147, 058	396, 103
Livingston	295, 232	63, 907	15, 049	78, 956
Madison	301, 916	68, 610	21, 764	90, 374
Monroe	332, 363	32, 524	13, 790	46, 314
Montgomery	200, 798	29, 411	6, 650	36, 061
New York	....	....	....	....
Niagara	257, 998	35, 709	9, 868	45, 577
Oneida	501, 099	135, 369	67, 895	203, 264
Onondaga	373, 516	54, 425	25, 222	79, 647
Ontario	314, 578	64, 616	7, 528	72, 144
Orange	321, 411	90, 354	60, 564	150, 918
Orleans	192, 600	28, 393	10, 300	38, 693
Oswego	313, 163	126, 183	67, 037	193, 220
Otsego	454, 572	135, 373	17, 743	153, 116
Putnam	87, 238	31, 284	20, 607	51, 891
Queens	117, 686	29, 736	24, 561	54, 297
Rensselaer	299, 786	55, 370	27, 569	82, 939
Richmond	11, 454	3, 874	3, 363	7, 237
Rockland	43, 147	23, 865	35, 731	59, 596
Saint Lawrence	712, 717	601, 520	294, 400	895, 920
Saratoga	317, 201	89, 192	59, 026	148, 218
Schenectady	95, 116	14, 498	8, 395	22, 893
Schoharie	280, 452	88, 672	9, 093	97, 765
Schuyler	147, 581	38, 506	9, 378	47, 884
Seneca	165, 360	21, 062	12, 357	33, 419
Steuben	503, 014	203, 895	110, 567	314, 462
Suffolk	156, 760	102, 550	129, 135	231, 685
Sullivan	191, 006	162, 163	170, 987	333, 150
Tioga	199, 920	74, 907	21, 427	96, 334
Tomkins	223, 536	50, 187	23, 653	73, 840
Ulster	272, 207	223, 612	124, 656	348, 268
Warren	136, 981	166, 288	50, 733	217, 021
Washington	346, 518	108, 084	18, 564	126, 648
Wayne	284, 996	50, 013	24, 665	74, 678
Westchester	174, 089	35, 773	28, 754	64, 527
Wyoming	281, 495	79, 576	3, 875	83, 451
Yates	163, 388	35, 799	8, 661	44, 460
Indian reservations	23, 080	1, 738	501	2, 239
Total	15, 891, 015	6, 259, 951	3, 426, 000	9, 785, 951

timber, for building purposes, or sawing into shingles or staves, and other uses, or cutting for fencing or fire-wood. Whenever this column is less than the preceding, the difference will be understood as showing the extent of sandy and barren tracts, salt meadows, swamps, marshes, rocky wastes, and other treeless and unimproved lands. Land from which the wood has been cut off, and which has been left to grow up another crop of timber, should *not* be entered in this column as 'timber land,' unless the growth is now available for present use."

The lumber region of Northern New York.

Around the upper waters of the Hudson, between Lake Champlain and the Black River, and northward of the Mohawk, lies a large elevated and broken region, almost wholly covered with forests, and a large part of it unfit for cultivation on account of swamps, broken ridges of rock, poverty of soil, and liability to summer frosts. The eastern part is mountainous, and this region, by those living to the eastward, is often known as the "Adirondac Wilderness," while on the western border, from a conspicuous but unsuccessful attempt at settlement at an early period by Mr. John Brown, of Providence, R. I., the whole region has received the name of "Brown's Tract," although strictly applicable to only a small part in Herkimer and Lewis Counties.

No separate statements of the timber and lumber product of this region can be given, excepting as they may appear in statistics of transportation. A few years since, a project was entertained of holding a part of this forest region as a State park, in order to insure permanence in the water-supply for the State canals, and for manufacturing interests, but insuperable difficulties were found in the fact that the soil belonged chiefly to private owners, and could not be acquired without unreasonable cost. Furthermore, the physical conditions of the region are such that it must forever remain an uninhabited district—often overrun by fires and cut over where accessible by lumbermen, but when left to itself producing new growths of timber and a feeble profit upon capital.

Within the last twenty years extensive tanneries along the western, southern, and eastern borders have made havoc with the native hemlock timber, which seldom or never is found coming up as a new growth. Much of the timber after peeling has been left to perish, the present conditions of the markets scarcely paying the cost of cutting and transportation.

The proposed Adirondac Park of Northern New York.

Around the head-waters of the Hudson, in Northern New York, including also a large region drained by the Black, Indian, Oswegatchie, Grass, Racket, Saint Regis, Salmon, and Ausable Rivers, and their tributaries, is a wilderness—for the most part an elevated plateau—interspersed with swamps and lakes, and on the eastern part broken by lofty mountains. It is surrounded by a well-settled region, but it has itself proved incapable of agricultural improvement, being generally frosty and barren. It has been an important source of supply for pine timber, but much of this has been removed, wherever accessible to waters suitable for floating. It still, however, furnishes a large amount of the coarser kinds of lumber, and supports a considerable number of large tanneries. Its chief economical value appears to be for the growth of timber, and wood for fuel and charcoal, the latter being needed for metallurgical operations, especially on its eastern border, where rich iron mines occur. The waters from this region afford valuable hydraulic power, and are taken from its southwestern part for feeding the Erie Canal, which could scarcely be kept navigable in summer but for this source of supply. The streams that traverse this region are navigable by canoes for long distances, and with occasional portages travelers can go entirely across, from the settlements on the Black River and the Saint Lawrence, to those along Lake Champlain, the general elevation of these waters being about 1,700 feet above tide. This circumstance renders it a favorite resort in summer, on account of its picturesque scenery, abundance of lakes, and attractive opportunities for sportsmen.

These considerations, but chiefly those looking to its importance for

the maintenance of its waters for the canals, and for hydraulic power, led to the passage of a State act, May 23, 1872, for the appointment of Commissioners of Parks for the State of New York. The act named seven persons,[1] citizens of the State, who were directed to "inquire into the expediency of providing for vesting in the State the title to the timbered regions lying within the counties of Lewis, Essex, Clinton, Franklin, Saint Lawrence, Herkimer, and Hamilton, and converting the same into a public park; such commissioners to report the results of their labors, together with such suggestions as they may have to present, to the legislature at its next session."

The commission was to continue two years, and one report was made (New York Senate Doc. 102, 1873), in which the subject was reviewed generally, and statements were presented showing the conditions that existed and the various rights that were concerned.

It was found that this vast region, formerly owned by the State, had been mostly conveyed to purchasers who had bought it for timber and bark, excepting a tract of over a quarter of a million of acres, which had been conveyed at the nominal price of five cents an acre to the "Sacket's Harbor and Saratoga Railroad Company," under a scheme of speculation little less than fraudulent, and that in fact the State owned but a small fraction of the territory, in detached parcels, and amounting in all to less than forty thousand acres.

It further appeared that the lands in this region which had been bought for the timber only were in many cases abandoned by their owners, when this was removed, as being no longer worth to them the taxes due on wild lands, and that in this way large tracts had been repeatedly sold for arrears of taxes or left in possession of the State as not worth these claims, until in the course of years another growth of timber had again made them desirable, and they were again bought from the State, to be again abandoned when stripped of everything valuable upon them. It was, moreover, quite probable that, should a project for repurchase be brought forward, the owners would take measures for an agreement to enhance the price to an unreasonable amount.

In the mean time the whole region must remain as it had been from time immemorial, covered with a forest growth, more or less dense, yet for all practical purposes sufficient to answer the wants of the State, as a shelter for the sources of rivers, and as a retreat for game. The most economical means for securing the desired park as State property, would doubtless be to withhold these wild lands from sale for arrears of taxes until these arrears amounted to their value, and then to declare them vested permanently in the State. By this means a large part would be gradually returned to the public, when by judicious supervision some revenue might be derived from the sale of timber.

No steps have, however, been taken toward securing this result, although the course above suggested has been brought to the notice of the legislature by the State engineer and surveyor, in whose charge the wild lands of the State are more immediately placed.

Glens Falls and the lumber interests of the Upper Hudson, Northern New York.[2]

The lumbering business on the Hudson River dates back to an early period in the history of the country. Mrs. Grant, in her "Memoirs of an

[1] These commissioners were Horatio Seymour, Patrick H. Agan, William B. Taylor, George H. Raynor, William A. Wheeler, Verplanck Colvin, and Franklin B. Hough.

[2] We are indebted to Dr. A. W. Holden, of Glens Falls, author of the History of Queensbury, New York, for the principal statements in this article.

American Lady," speaks of timber-rafts being floated down to Albany as far back as 1758. Saw-mills were erected at Glens Falls in 1770, and from that time to the present the manufacture and export of timber has constituted one of its most important industries. But the once heavily-timbered pine forests have receded before the ax of the lumberman, until far away among the sources of the mountain rivulets at the north there is only left here and there a scattered remnant of these towering and stately ornaments of the woods. Since 1850 the manufacture of pine timber has formed but an inconsiderable item in the product of the Hudson River mills. In addition to the destructive fires which from time to time have devastated the mountains, and cleared the forests along the line of the border settlements, the death of the spruces, from some mysterious cause, has stripped the forest of its evergreens, and in many instances necessitated the ingathering of thousands of logs to save them from becoming a loss through natural decay. Nevertheless, as fifty spruce-trees to the acre is considered a liberal estimate, and the surrounding woods are often so heavily timbered with other growths as to make it difficult to fall the spruces without lodgment, the clearing away of the dead wood makes but little difference in the general aspect or density of the forest. On the southeast side of the great Adirondack plateau the hemlock-producing belt extends but little, if any, north of the Warren County line. A few isolated clumps, a gnarled and dwarfed specimen at widely recurring intervals, are but the exceptions which establish the rule. The consumption of the deciduous forest-trees within the lumber district proper has not yet entered as a factor in the lumber product. The relatively few dock-sticks, spars, and pieces of round timber which find their way to market down the river, or by the Glens Falls feeder, are nearly or quite all obtained at points within the range of settlements, and south of the wilderness border. The lumber region tapped by the Hudson and its affluents is relatively small as compared with the vast water-shed drained by the Racket and its tributaries, to say nothing of the Black, the Oswegatchie, the Grass, and the Saint Regis Rivers, all of which contribute to swell the majestic flood of the Saint Lawrence. And yet, along the ponds and marshes, and headwaters of the Schroon, the Sacandaga, the North, Boreas, Indian, Cedar, and Rock Rivers, are to be found extensive and untouched tracts of timber of as good quality as any ever brought to market.

It is worthy of mention, that while of the second growth of white pine the quality is greatly inferior to that of " the forest primeval," the same is not true of either the spruce or the hemlock, the younger and newer trees being preferable as producing the strongest, soundest, and most desirable grades of lumber. Another interesting fact in this connection is that considerable tracts of territory on the borders of, and within, the great wilderness, which have been cleared by the ax of the settler, or denuded by destructive fires, are again covered with a dense second growth of trees; and it is confidently asserted by those whose judgment should be competent, that there is to-day a larger area of forest in " the great north woods," than there was twenty-five years ago; and that this condition is relatively increasing, notwithstanding the enormous consumption of the lumber producing evergreens. It is a mistake to suppose that the Adirondack wilderness is being cleared up.

River-driving is a feature in the lumbering business which came in vogue about fifty years ago. Previous to that time the practice prevailed of erecting small mills of feeble capacity and primitive machinery on brooks, rivulets, or by the aid of wing-dams, on the banks of rivers near the sources of supply. This system was attended with great waste

of labor and material. As the outgrowth of our cities and the demands of commerce increased, mechanical inventions multiplied, the economies of manufacture were studied, extensive mills with all the adjuncts of machinery were constructed at central points, and logs were drawn or floated to the mills from the ponds above. As the cost of production increased, and material receded, combinations of operators were organized, river-driving became systematized, and manufacturing at the great centers of the lumbering business steadily increased.

This mode of operating necessitated the accumulation, at seasons of high water, of large quantities of logs for the year's supply. At this day the points of supply and consumption are so remote that one and often part of two years' stocks, representing from three-fourths to a million of dollars, are constantly afloat. A system of booms was devised in order to retain and convey the logs to the points where they were to be sawed. But it was found that enormous losses frequently resulted from freshets. Once in four or five years, sometimes oftener, a tremendous spring-flood would occur, which no amount of precaution or care could (or did) prevent from bearing off on its resistless, turbulent, and turbid waters the gathered harvest of an entire year's work in the woods, leaving the mills idle for the want of stock; and the employés thus thrown out of their regular work were forced to seek in other fields of industry a scanty and precarious employment.

To remedy these evils, "The Hudson River Boom Association" was formed about the year 1849. This combination included all the mill-owners below the Great Falls on the Hudson River (Jessup's Falls), together with many log-owners, who had their lumber made at their mills. At great expense a substantial series of piers and system of chained booms was constructed at the foot of the Big Bend, about four miles above Glens Falls, which, strengthened and improved from time to time, has never failed to accomplish the work for which it was designed, and to withstand the pressure of the heaviest freshets. In order to equalize the annual expenses attendant upon the management of the boom, and the reception and discharge of the logs, a record of the number delivered and sworn to by each contributor to the drive had to be kept by the Boom Association, and thus we are enabled, through the courtesy of its secretary, Mr. William McEachron, of Glens Falls, to present in a tabulated form the number of logs received for the last twenty-five years, with the exception of two years, which are estimated. It is premised that each unit of the count here given is a *market-log*, viz, a log thirteen feet long and nineteen inches in diameter in the clear at the smaller end. Such a log, calculated as a cylinder, contains 25.6 cubic feet, and practically represents about 200 feet of sawed lumber, board-measure. As the average of stock runs in the boom, including logs of all sorts, each market-log will represent two pieces by count, and the actual number of logs delivered to the various drives is obtained by multiplying the numbers of the table by 2.

The amount of lumber carried to market by rail is very inconsiderable and scarcely worth mentioning. By estimates, it would not exceed 1 per cent., so that the following table from canal statistics will represent the principal production that reached the great markets. The number of market-logs manufactured at points above the Big Boom is roughly estimated at 25,000, representing 5,000,000 feet of lumber per annum.

Market-logs received at the Big Boom from the time of its construction, in 1851, to the present time.

[From the books of the Hudson River Boom Association.]

Years.	Market-logs.	Years.	Market-logs.	Years.	Market-logs.
1851	132, 500	1861	300, 000[1]	1871	551, 000
1852	345, 400	1862	300, 000[1]	1872	1, 069, 000
1853	303, 000	1863	310, 000	1873	824, 000
1854	297, 000	1864	279, 000	1874	446, 000
1855	302, 500	1865	292, 000	1875	563, 000
1856	292, 500	1866	507, 000	1876	575, 500
1857	298, 000	1867	832, 000	1877	575, 000[1]
1858	332, 000	1868	600, 000		
1859	400, 000	1869	543, 000	Total	12, 309, 400[2]
1860	353, 000	1870	687, 000		

[1] No report; estimated.
[2] Equal to 2,461,880,000 feet of lumber in 27 years; = 91,180,741 feet on the general average per annum.

The manufacturing on the Upper Hudson (except the limited amount above Jessup's Falls) is divided between Glens Falls, Sandy Hill, Fort Edward, and Fort Miller, much the larger amount being at the first of these places.[1] In the absence of other data, we take the official canal reports, showing the amount cleared at different offices in *tons* of 2,000 pounds, and *value*. Before 1858, entries were divided between the offices at *Glens Falls* and *Schuylerville*, but since then at *Fort Edward*, which represents the business formerly transacted at both of the former offices.

Tons and value of forest products cleared on the Champlain Canal and Glens Falls Feeder since 1849, at points on the Upper Hudson.

GLENS FALLS.

Years.	Boards and scantling.		Shingles.		Timber.		Staves.		Wood.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.
1849	37, 145	$189, 437	27	$456	3, 334	$10, 153	63	$502	2, 599	$2, 599
1850	44, 958	249, 000	16	524	1, 271	2, 812	104	832	1, 538	2, 366
1851	37, 898	204, 651	24	945	1, 499	2, 046	53	422	3, 915	4, 350
1852	52, 577	315, 460	26	425	1, 598	4, 794	97	772	9, 433	8, 423
1853	61, 492	397, 001	19	162	6, 269	31, 591	24	....	3, 447	12, 428
1854	65, 946	356, 108	6	205	40, 607	142, 126	390	3, 895	14, 221	12, 697
1855	69, 601	375, 844	19	471	32, 918	115, 213	179	449	11, 693	13, 572
1856	83, 327	428, 540	2	48	40, 316	403, 166	71	709	6, 184	7, 730
1857	61, 266	408, 438	17	276	15, 172	45, 515	139	1, 399	13, 518	12, 070

SCHUYLERVILLE.

Years.	Boards and scantling. Tons.	Boards and scantling. Value.	Shingles. Tons.	Shingles. Value.	Timber. Tons.	Timber. Value.	Staves. Tons.	Staves. Value.	Wood. Tons.	Wood. Value.
1849	11, 361	102, 248	19	507	1, 524	6, 097	74	596	4, 355	10, 440
1850	13, 814	124, 326	11	302	1, 810	7, 244	37	299	1, 076	9, 783
1851	30, 014	300, 141	10	300	7, 737	46, 422	2	30	7, 918	12, 664
1852	37, 247	268, 181	82	1, 647	6, 166	30, 807	15	150	9, 996	10, 710
1853	47, 262	397, 001	7	162	5, 744	31, 591	....	....	11, 600	12, 428
1854	40, 838	245, 033	4	120	18, 095	81, 406	....	....	9, 267	13, 238
1855	40, 962	245, 777	......	....	1, 062	4, 776	....	....	7, 232	10, 332
1856	55, 280	368, 536	16	321	1, 103	5, 516	53	533	5, 894	6, 315
1857	44, 767	298, 446	3	1, 028	629	3. 149	8	80	5, 814	8, 306

[1] The Big Bend referred to in the text, is about four miles above Glens Falls, where the boom is located. Two miles below is the State dam for feeding the summit-level of the Champlain Canal, and here at either end of the dam are two saw-mills. Two other establishments occur at the Falls. Another large establishment, run by steam, is located on the canal, two miles below Glens Falls, and others at each of the places named.

Tons and value of forest products cleared on the Champlain Canal, &c.—Continued.

FORT EDWARD.

Years.	Boards and scantling.		Shingles.		Timber.		Staves.		Wood.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.
1858.....	86, 805	520, 828	28	909	29, 159	102, 057	218	1, 088	18, 620	23, 275
1859.....	109, 844	659, 065	20	560	36, 657	73, 315	226	2, 260	25, 150	13, 473
1860.....	100, 728	604, 369	5	147	20, 267	14, 534	385	962	27, 339	14, 646
1861.....	110, 457	662, 743	1	24	30, 760	61, 520	164	410	19, 816	10, 616
1862.....	98, 820	592, 920	2	54	15, 112	30, 225	150	375	12, 667	6, 786
1863.....	134, 692	1, 212, 233	10	320	30, 078	60, 158	729	3, 648	27, 470	24, 528
1864.....	122, 242	1, 100, 180	10	304	6, 884	189, 745	292	7, 845	15, 064	37, 917
1865.....	122, 700	1, 104, 297	......	....	19, 135	143, 514	882	8, 828	32, 262	34, 566
1866.....	129, 172	1, 550, 064	32	1, 036	16, 392	122, 942	492	4, 920	29, 260	31, 350
1867.....	138, 654	1, 663, 843	1	40	15, 313	114, 849	649	6, 485	21, 610	23, 154
1868.....	180, 571	1, 625, 140	64	2, 060	17, 049	127, 868	500	5, 000	29, 656	31, 774
1869.....	163, 583	1, 472, 245	......	....	27, 893	209, 199	....	....	24, 444	26, 190
1870.....	141, 720	1, 275, 480	1	16	4, 613	34, 610	14	144	16, 667	17, 868
1871.....	172, 898	2, 074, 773	48	1, 155	7, 454	55, 893	3	30	21, 378	15, 270
1872.....	217, 247	1, 955, 222	57	1, 844	11, 838	59, 192	1, 690	4, 225	34, 165	24, 404
1873.....	153, 932	1, 385, 389	......	....	14, 065	70, 321	2, 642	13, 208	31, 937	22, 812
1874.....	200, 177	1, 801, 589	4	132	7, 760	58, 197	825	8, 250	24, 972	26, 745
1875.....	188, 935	1, 360, 329	3	108	10, 772	53, 858	3, 458	17, 290	31, 417	22, 441

Other interests connected with the wilderness of Northern New York.

The manufacture of iron in Essex and Clinton Counties has for a long period created a demand for charcoal, which the forest has supplied, in some cases by repeated cuttings. The tributaries of Lake Champlain, and especially the Ausable, which drains an extensive region in the interior, have been and still are important lumbering regions, the product, after supplying local demand, usually finding a market by the way of the Champlain Canal. A considerable amount of hewn timber has passed from this region down the Saint Lawrence to Quebec.

The completion of a railroad from Ogdensburgh to Lake Champlain in 1850 opened an avenue to market for the northern part of the great wilderness, and brought into use several of the rivers that had their sources in the pine region, and were of sufficient size for floating. Extensive lumbering establishments sprang up on the Chazy, Chateaugay, Salmon, Saint Regis, Grass, Racket, and Oswegatchie Rivers, but of these none will compare with the Racket in the extent of territory drained and amount of business done. Extensive establishments were formed at Potsdam and other points, and large quantities of manufactured goods have been shipped to Boston and other points. The principal part of the lumber from this region has found its way to market through the Champlain Canal.

The pine timber of the western borders of the wilderness mostly disappeared some twenty years ago, but a very limited supply being now produced. The lumber stations on the lower waters of the Black River have been mostly given up, and operations are now chiefly limited to the Beaver, Otter, and Moose Rivers, and the upper waters of the Black River, the products going southward by canal and railroad. The streams flowing southward from the wilderness into the Mohawk, having importance with lumbermen, are the East and West Canada Creeks, and especially the latter.

Pine forests on the upper waters of the Genesee, Canisteo, and Allegheny Rivers in Southwestern New York.

An area roughly estimated as fifty miles long by five wide, but very irregular in form, on the upper waters of the Genesee, was originally covered with a heavy growth of white pine. Other extensive tracts occurred around the upper waters of the Allegheny, which found a natural outlet by way of Pittsburgh to southwestern markets, and others

around the waters tributary to the Susquehanna, especially the Canisteo, which found a market by rafting down to Chesapeake Bay. The completion of the line now known as the Erie Railway, and the Chemung and Genesee Valley Canals, opened other avenues to market, so that now a very considerable part of the pine of this region most convenient of access has been cut, and the lumber business has declined or ceased altogether in many places where it was once important.

The recent measures taken for the relinquishment of these canals by the State is a significant proof that there are no longer any great business interests along their line that demand their continuance. The exportation of boards and scantling at Dansville had declined from nearly 10,000,000 feet to less than a tenth of this amount; that of shingles from 2,000,000 to 150,000, and staves from over 1,000 tons to nothing. The timber business on the Genesee Valley Canal was most important at Mount Morris and Caneadea, and the lumber and stave business at Olean, which still remains a prominent lumbering point. The rafting of timber on the Susquehanna and Delaware Rivers is still continued, but greatly reduced in amount, and every year less. The largest lumbering point on the Chemung River is at Painted Post, near Corning.

The white-oak timber of Western New York was, in the early years of canal navigation, an important object of industry, and the supply is still considerable, but much less is done in this business than formerly. The quality of this timber was very superior for stave and ship timber, for which uses it was best adapted.

Lumber production of the State of New York.

For the local consumption of lumber in this State there are no data for estimate. The completion of the Erie Canal in 1825 opened an avenue for market which stimulated production in many places, and the statistics of tonnage published annually by the State government enable us to know with much certainty the amount thus shipped, and might be used in specifying the quantities received and delivered at each point on the lines of the canals. These statistics are generally given in tons of 2,000 pounds and in values; and for the conversion of tons to measured quantities, rules have been established for the guidance of inspectors and collectors. From these we have prepared the following table, adding, from such information as we have, the botanical names of the different kinds of timber that usually pass over the canals. The quantities designated as *feet* will be understood as superficial or board measure.

Weight of green and dry lumber. (Canal regulations.)

Kind of lumber.	Botanical species.	Weight per foot		Feet per ton (2,000 lbs.).		Weight per M feet. (Tons, 2,000 lbs.)	
		Dry.	Green.	Dry.	Green.	Dry.	Green.
Ash	*Fraxinus* (various species)	3.5	4.5	571.4	444.4	1.75	2.25
Basswood	*Tilia Americana*	2.0	3.5	1,000.0	571.4	1.00	1.75
Beech	*Fagus ferruginea*	3.5	4.5	571.4	444.4	1.75	2.25
Black walnut	*Juglans nigra*	3.5	5.5	571.4	363.7	1.75	2.75
Cedar	*Thuja occidentalis*[1]	2.25	2.5	888.9	800.0	1.125	1.25
Cherry	*Cerasus serotina*	3.5	5.5	571.4	363.7	1.75	2.75
Elm	*Ulmus* (various species)	3.0	4.0	666.7	500.0	1.50	2.00
Hemlock	*Abies Canadensis*	2.5	3.5	800.0	571.4	1.25	1.75
Hickory	*Carya* (various species)	3.5	4.5	571.4	444.4	1.75	2.25
Maple	*Acer* (various species)	4.0	5.5	500.0	363.7	2.00	2.75
Oak	*Quercus* (various species)	4.0	5.5	500.0	363.7	2.00	2.75
Spruce	*Abies nigra*	2.25	3.5	888.9	571.4	1.125	1.75
Sycamore	*Platanus occidentalis*	3.0	4.0	666.7	500.0	1.50	2.70
White pine	*Pinus strobus*	2.5	3.5	800.0	571.4	1.25	1.75
Whitewood	*Liriodendron tulipifera*	2.25	3.5	888.9	571.4	1.125	1.75

[1] "White Cedar." In much less quantity, the *Juniperus Virginiana*, or "Red Cedar."

Other official rules for reduction.

The following general rules are also laid down for the guidance of officers in charge of the New York canals in converting measurement into tonnage:

1. *To reduce feet of boards and scantling to tons.*—Divide the number of feet by 6, and point off two figures from the right as decimals. (This rule is based on a general average of 3⅓ pounds to the foot = 600 feet to the ton = 1.6 tons per 1,000 feet.)

2. *To reduce shingles by the thousands, to tons.*—Divide the number of thousands by 8. (This assumes a thousand shingles to weigh 250 pounds.)

3. *To reduce cubic feet of timber to tons.*—Divide the number of cubic feet by 5 and point off one figure. (This assumes the cubic foot to average 40 pounds in weight.)

To reduce cords of wood to tons.—Multiply the number of cords by 28 and point off one figure. (This assumes that a cord weighs 2⅘ tons, or 4,250 pounds, or about 33⅓ pounds to the cubic foot.)

To reduce barrels of pot and pearl ashes to tons.—Multiply the number of barrels by 275 and point off three figures. (This assumes that a barrel of pot or pearl ashes weighs 550 pounds = 3.63 barrels to the ton.)

Tons of forest products carried on New York canals from points within the State.

Years.	Arriving at tide-water.		Internal movement.	Total tons, the produce of the State of New York, carried on canals.	Percentage of total amount of forest products carried.
	By Erie Canal.	By Champlain Canal.			
1836	208, 779	213, 538	281, 589	703, 906	93. 2
1837	174, 007	165, 419	233, 694	573, 120	92. 7
1838	189, 733	172, 031	264, 212	625, 976	94. 1
1839	157, 075	143, 894	289, 870	590, 839	88. 5
1840	119, 352	137, 264	265, 927	522, 543	88. 3
1841	192, 123	167, 679	196, 453	556, 254	86. 2
1842	125, 623	102, 006	183, 116	410, 745	89. 3
1843	202, 810	154, 457	271, 011	628, 278	91. 4
1844	288, 986	166, 676	319, 171	774, 833	89. 6
1845	328, 955	169, 651	273, 844	772, 450	87. 6
1846	320, 838	171, 120	313, 966	805, 924	89. 0
1847	328, 652	187, 196	421, 601	937, 449	86. 2
1848	264, 549	175, 037	483, 608	923, 194	84. 9
1849	227, 847	179, 891	439, 393	847, 131	79. 7
1850	268, 894	247, 799	314, 223	830, 916	65. 9
1851	223, 657	294, 399	480, 430	998, 486	72. 9
1852	290, 574	355, 779	521, 403	1, 167, 756	73. 7
1853	391, 224	394, 620	481, 261	1, 267, 105	69. 6
1854	357, 690	260, 617	665, 727	1, 284, 034	73. 0
1855	220, 865	222, 963	657, 129	1, 100, 957	71. 7
1856	173, 608	280, 027	619, 903	1, 073, 538	72. 7
1857	66, 824	236, 381	565, 016	868, 221	63. 7
1858	147, 511	216, 160	415, 355	779, 026	63. 1
1859	226, 450	272, 964	418, 428	917, 842	59. 5
1860	166, 687	266, 983	372, 104	805, 774	53. 4
1861	104, 094	234, 761	361, 806	700, 661	66. 6
1862	143, 246	226, 685	601, 612	971, 543	61. 9
1863	145, 105	278, 505	579, 129	1, 002, 739	61. 6
1864	61, 167	247, 598	372, 773	681, 538	46. 8
1865	23, 152	277, 832	415, 699	716, 684	48. 8
1866	101, 665	315, 299	440, 110	857, 074	48. 4
1867	22, 855	324, 885	384, 965	732, 705	42. 1
1868	20, 517	365, 620	498, 956	885, 093	45. 2
1869	15, 493	385, 472	402, 511	803, 476	42. 1
1870	18, 340	281, 583	450, 994	750, 917	39. 2
1871	13, 457	326, 233	539, 468	879, 158	45. 3
1872	4, 662	322, 840	482, 933	810, 435	41. 6
1873	116, 156	362, 424	277, 064	755, 644	47. 7
1874	35, 592	254, 558	290, 072	579, 714	39. 2
1875	....	198, 010	437, 271	635, 281	50. 8

Tons of forest products of the State of New York carried upon the New York canals since 1835.

Years.	Boards and scantling.	Shingles.	Timber.	Staves.	Wood.	All forest products.
1835	278, 730	....	20, 190	44, 532	129, 090	....
1836	321, 635	....	100, 144	18, 713	247, 551	....
1837	226, 221	....	42, 783	25, 291	261, 921	....
1838	259, 200	....	42, 673	31, 578	275, 250	....
1839	250, 364	....	54, 332	21, 912	245, 484	590, 839
1840	210, 497	....	54, 889	15, 645	225, 672	523, 519
1841	307, 241	....	79, 283	29, 681	126, 389	559, 997
1842	273, 526	....	29, 565	11, 843	120, 624	453, 370
1843	309, 689	....	51, 821	15, 332	228, 100	629, 744
1844	403, 186	....	51, 495	21, 233	273, 616	774, 534
1845	398, 234	13, 738	72, 898	23, 940	251, 842	772, 360
1846	432, 917	14, 496	72, 780	31, 623	246, 955	805, 924
1847	504, 954	33, 332	67, 274	22, 539	302, 730	937, 449
1848	453, 794	23, 676	56, 156	20, 729	363, 306	923, 194
1849	441, 849	18, 024	45, 745	20, 366	316, 421	847, 131
1850	486, 714	11, 543	76, 719	25, 424	269, 383	876, 432
1851	581, 495	14, 906	96, 643	37, 008	311, 167	1, 045, 669
1852	639, 216	14, 635	85, 945	21, 163	403, 208	1, 167, 756
1853	755, 581	19, 124	104, 797	19, 383	364, 686	1, 267, 108
1854	673, 462	10, 356	163, 846	23, 240	427, 204	1, 283, 134
1855	534, 875	15, 131	95, 904	24, 015	428, 741	1, 100, 957
1856	591, 448	14, 487	109, 653	30, 515	313, 660	1, 063, 538
1857	472, 061	12, 914	67, 376	32, 010	277, 744	868, 221
1858	514, 477	14, 150	59, 994	40, 255	146, 569	779, 026
1859	582, 330	15, 418	86, 043	44, 681	186, 182	918, 442
1860	518, 622	11, 921	62, 893	37, 143	173, 632	805, 774
1861	382, 577	10, 053	68, 572	36, 975	200, 833	700, 661
1862	457, 502	11, 440	74, 454	37, 865	387, 574	971, 543
1863	518, 610	8, 393	85, 368	40, 636	348, 496	1, 002, 739
1864	414, 926	7, 482	19, 131	24, 449	224, 391	661, 538
1865	394, 385	5, 441	46, 798	32, 090	236, 556	716, 683
1866	510, 422	14, 644	75, 479	28, 445	227, 424	857, 074
1867	507, 982	9, 514	46, 084	31, 342	135, 387	732, 706
1868	583, 342	8, 306	40, 309	74, 475	152, 769	886, 093
1869	596, 704	8, 325	65, 616	17, 273	88, 129	803, 485
1870	550, 419	10, 759	34, 350	50, 031	96, 680	750, 917
1871	553, 690	44, 549	31, 103	22, 241	79, 814	879, 158
1872	676, 259	4, 483	40, 604	9, 296	81, 466	809, 435
1873	607, 323	2, 491	36, 955	15, 876	88, 821	752, 181
1874	442, 313	4, 409	41, 897	16, 337	74, 441	580, 222
1875	385, 411	1, 635	37, 852	9, 757	78, 138	513, 524

Annual averages of the foregoing, in five-year periods. (Tons.)

Periods.	Boards and scantling.	Shingles.	Timber.	Staves.	Wood.	All forest products.
1835–1839	267, 230	....	52, 024	28, 405	231, 859	579, 519
1840–1844	300, 828	....	53, 411	18, 747	194, 880	588, 233
1845–1849	446, 350	20, 653	62, 971	23, 839	296, 251	857, 212
1850–1854	627, 294	14, 113	105, 590	25, 244	355, 130	1, 128, 020
1855–1859	539, 038	14, 420	83, 794	34, 295	270, 579	946, 037
1860–1864	458, 447	9, 858	62, 084	35, 414	266, 985	832, 451
1865–1869	519, 567	9, 246	54, 857	36, 725	168, 052	799, 208
1870–1874	566, 001	13, 338	36, 982	22, 756	84, 244	754, 383

General summary of whole period.

Boards and scantling, 1835 to 1875, inclusive (41 years), 19,004,182 tons .... =11,402,509,200 feet.
Shingles, 1845 to 1875, inclusive (31 years), 409,775 tons .... =3,278,200 M.
Timber, 1835 to 1875, inclusive (41 years), 2,596,413 tons .... =129,820,650 cubic feet.
Staves, 1835 to 1875, inclusive (41 years), 1,136,882 tons.
Wood, 1835 to 1875, inclusive (41 years), 9,418,041 tons .... =3,363,586 cords.

Number of cribs of timber passing Alexander's lock (eastward) since 1860.

Year.	Number.	Year.	Number.
1860	1, 617	1868	1, 036
1861	1, 018	1869	560
1862	2, 155	1870	1, 444
1863	2, 062	1871	1, 067
1864	2, 728	1872	1, 074
1865	1, 868	1873	1, 143
1866	1, 468	1874	1, 984
1867	1, 746	1875	556

Tons of forest products carried on New York canals from points beyond the State.

Years.	From Canada and Western States by way of Erie Canal.	From Canada and Vermont by way of Champlain Canal.	Total from Canada and other States.	Percentage of total amount of forest products carried.	Years.	From Canada and Western States by way of Erie Canal.	From Canada and Vermont by way of Champlain Canal.	Total from Canada and other States.	Percentage of total amount of forest products carried.
1836	5, 400	45, 951	51, 351	6. 8	1857	436, 604	59, 177	495, 781	36. 3
1837	7, 637	37, 954	45, 591	7. 3	1858	391, 139	62, 803	453, 942	36. 8
1838	9, 231	29, 882	39, 113	5. 9	1859	550, 405	73, 788	624, 193	40. 5
1839	28, 664	48, 098	76, 762	11. 5	1860	647, 705	56, 498	704, 203	46. 6
1840	21, 241	43, 861	65, 102	11. 7	1861	325, 230	26, 501	351, 731	33. 4
1841	45, 398	43, 896	89, 294	13. 8	1862	563, 346	34, 785	598, 131	38. 1
1842	31, 069	22, 783	53, 852	10. 7	1863	537, 110	88, 839	625, 949	38. 4
1843	36, 775	22, 131	58, 906	8. 6	1864	654, 850	142, 533	797, 383	53. 2
1844	68, 088	21, 652	89, 740	10. 4	1865	603, 937	146, 695	750, 632	51. 2
1845	91, 235	18, 179	109, 414	12. 4	1866	706, 385	206, 535	912, 920	51. 6
1846	87, 010	24, 042	101, 052	11. 0	1867	814, 726	196, 820	1, 011, 546	57. 9
1847	117, 233	32, 942	150, 175	13. 8	1868	891, 071	182, 145	1, 073, 216	54. 8
1848	142, 433	21, 253	163, 686	15. 1	1869	857, 938	194, 516	1, 052, 454	57. 9
1849	214, 259	43, 550	257, 809	20. 3	1870	937, 799	227, 795	1, 165, 594	60. 8
1850	329, 062	102, 013	431, 075	34. 1	1871	857, 195	204, 944	1, 062, 139	54. 7
1851	328, 688	66, 524	395, 212	27. 1	1872	885, 478	254, 885	1, 140, 363	58. 4
1852	336, 892	81, 432	418, 324	26. 3	1873	809, 379	20, 512	829, 891	52. 3
1853	444, 080	110, 337	554, 417	30. 4	1874	719, 609	182, 922	902, 531	60. 8
1854	380, 677	104, 034	484, 711	27. 0	1875	490, 000	125, 265	615, 265	49. 2
1855	348, 215	85, 762	433, 977	28. 3	1876	....	....	....	....
1856	335, 797	69, 339	405, 136	27. 3					

Lumber of different kinds coming from beyond the State; annual averages of five-year periods, showing the place where entered.

BOARDS AND SCANTLING (TONS).

Periods.	Buffalo.	Oswego.	Whitehall.	Total.
1835–'39	736	1, 063	30, 105	31, 904
1840–'44	4, 766	6, 807	24, 256	35, 829
1845–'49	39, 898	34, 841	20, 651	95, 390
1850–'54	99, 726	148, 004	68, 319	316, 049
1855–'59	99, 256	161, 366	60, 843	321, 465
1860–'64	143, 705	214, 528	50, 728	408, 961
1865–'69	244, 935	354, 073	164, 509	763, 517
1870–'74	330, 671	382, 066	167, 901	880, 637

SHINGLES (TONS).

1845–'49	119	326	48	492
1850–'54	967	783	4, 140	5, [illegible]89
1855–'59	529	252	105	886
1860–'64	2, 638	505	75	3, 278
1865–'69	3, 671	2, 214	232	6, 115
1870–'74	4, 764	1, 385	60	6, 209

Lumber of different kinds coming from beyond the State, &c.—Continued.

TIMBER (TONS).

State.	Buffalo.	Oswego.	Whitehall.	Total.
1835–'39	....	....	5, 390	5, 388
1840–'44	192	....	899	1, 091
1845–'49	2, 857	1, 453	4, 605	8, 915
1850–'54	18, 251	4, 558	19, 529	42, 339
1855–'59	87, 963	5, 873	81	93, 918
1860–'64	43, 266	4, 136	13, 336	60, 738
1865–'69	46, 111	4, 811	19, 309	70, 230
1870–'74	30, 124	21	8, 736	38, 881

STAVES (TONS).

1835–'39	6, 660	1, 775	43	8, 477
1840–'44	20, 898	860	....	21, 758
1845–'49	43, 441	1, 720	....	45, 161
1850–'54	61, 112	7, 492	8	68, 613
1855–'59	9, 054	20, 767	464	50, 284
1860–'64	133, 798	783	33	134, 614
1865–'69	115, 949	308	515	116, 772
1870–'74	97, 512	514	603	98, 629

WOOD (TONS).

1835–'39	....	....	5, 346	5, 346
1840–'44	....	....	5, 295	5, 295
1845–'49	144	42	1, 485	1, 671
1850–'54	177	....	119	296
1855–'59	9, 054	20, 767	464	30, 284
1860–'64	2, 020	3	5, 562	7, 585
1865–'69	2, 676	....	553	3, 229
1870–'74	69	111	703	883

ALL FOREST PRODUCTS (TONS).

1835–'39	8, 636	2, 925	41, 202	52, 761
1840–'44	30, 772	7, 980	30, 865	69, 617
1845–'49	91, 599	38, 853	27, 993	158, 445
1850–'54	183, 829	161, 511	93, 048	438, 388
1855–'59	215, 970	196, 462	70, 174	482, 606
1860–'64	325, 659	219, 990	69, 831	615, 479
1865–'69	413, 404	361, 408	185, 342	960, 154
1870–'74	455, 952	385, 940	214, 211	1, 020, 104

Transportation of forest products by railroad.

Two principal railroads, crossing the State from west to east, have within the last twenty years carried large amounts of forest products, chiefly the growth of the State. The aggregate amount is shown in the following table. It will be seen that while their aggregates for the whole period have been nearly equal, the Erie Railway has carried a much more uniform quantity than the New York Central. While the former has not doubled, the latter has increased more than twelve-fold. The Erie receives most of this freight along its line, while most of that coming upon the Central is from beyond the State.

Tons of forest products carried by the New York Central Railroad and the Erie Railway since 1856.

Years.	New York Central and Hudson River Railroad.	Erie Railway.	Years.	New York Central and Hudson River Railroad.	Erie Railway.
	Tons.	*Tons.*		*Tons.*	*Tons.*
1856	29, 547	116, 378	1868	100, 436	216, 123
1857	31, 468	126, 093	1869	122, 436	191, 629
1858	24, 368	92, 550	1870	224, 169	198, 620
1859	35, 154	97, 754	1871	174, 685	261, 272
1860	42, 305	118, 890	1872	317, 727	279, 725
1861	39, 310	108, 685	1873	425, 115	227, 112
1862	39, 479	99, 677	1874	458, 527	184, 464
1863	52, 829	102, 008	1875	383, 708	179, 514
1864	87, 584	104, 069	1876	408, 564	195, 865
1865	55, 718	99, 865			
1866	77, 443	173, 410	Total	3, 327, 607	3, 371, 418
1867	97, 035	197, 715			

Albany lumber market.

From its location at the tide-water end of the Erie and Champlain Canals, Albany, and, to a large extent, West Troy, have become the seat of a lumber-trade, which, in the aggregate value of sales, is unequaled in America, although in number of feet sold they are exceeded by Chicago. Waterford, in Saratoga County, has also become a point of trade, more especially in timber, of great importance. The supplies at this point come entirely from the Champlain Canal.

The lumber district of West Troy extends along the river bank, between the canal and river, for a considerable distance, toward the upper part of the village.

The lumber district of Albany lies between the Erie Canal and the Hudson River, from the former of which over thirty slips have been constructed for the convenience of unloading boats, while along the latter substantial piers have been built for loading vessels. The lumber district proper is bounded south by North Ferry street, where it is about 500 feet wide, and, gradually spreading as it runs northward, in the distance of something over a mile it becomes 1,150 feet wide between the canal and river, occupying in all an area of over 100 acres. The slips extend at right angles from the canal, on the berme side, to within about 150 feet of the river. The largest is about 1,000 feet long, and several have cost $25,000 each. The ground belongs to the Van Rensselaer family, and is rented at about 18 per cent. upon cost of construction. Of late years, the slips have been built by the dealer, who retains what he would have paid for rent, until this, with the interest upon it, amounts to the cost of construction, when the slip becomes the sole property of the landlord, and subject to rental as if built by him. A slip will pay for itself in this way, in about eight years.

Some forty firms and separate dealers are doing business in the Albany lumber district, and mostly within the limits above described. Many of them own mills in the lumber regions, and boats and vessels for transportation, while others buy or sell on commission, or on joint account. A number of them unite these various modes of dealing, and some are not limited to particular rules, and make arrangements as they find advantageous.

With reference to the sources of supply, and the regions supplied, the following is quoted from a little pamphlet printed in 1872:[1]

The principal sources of supplying pine timber to the Albany markets are Canada and Michigan. Canada furnishes the greater portion, and it is believed by some Albany dealers that before long this market will be obliged to rely almost entirely on that country for stock. They argue that, as the West is rapidly growing, and the available lumber in such manufacturing districts as Michigan is rapidly decreasing, Western demand will soon equal Western production. As an evidence of the soundness of this conclusion they adduce home instances. Certain sections of this State, they say, such as Chemung, Allegany, and Steuben Counties, seemed, not long ago, to possess inexhaustible resources for supplying a good quality of pine lumber. Now those localities are obliged to import the better grades of lumber used there from Canada, and New York State furnishes no pine lumber to the trade.

The coarser kinds of lumber, such as hemlock and spruce, come principally from Fort Edward, Glens Falls, Champlain, and the Saranac River. The great bulk of the Albany lumber is sold to dealers and consumers in New York City, New Jersey, and the Eastern States. A great deal of that sent to the metropolis is reshipped to different points along the Atlantic coast and elsewhere. Previous to the termination of the reciprocity treaty Albany did an immense foreign shipping business. Buenos Ayres, Chili, and other parts of South America, as well as Australia, directly contributed largely to the patronage of our dealers, but the imposition of a heavy duty diverted this trade from Albany and revolutionized the tactics of the foreign buyer. A great deal of the lumber now shipped to those countries is sent directly from Canada without touching the shores of the United States, and the duty is thereby avoided. * * * * *

Then and now.—In several particulars there is a striking difference between the past and present of the lumber interest in this city. Forty years ago the direct patron of the wholesale Albany lumber merchant was the captain of a sloop or schooner, who purchased his cargo upon thirty days' credit, and peddled it out in quantities to suit customers along the river, in New York City, or wherever he could find a market. Now, the boat captain merely acts as a paid agent for directing the transportation of merchandise from the dealer to the buyer. Then, the captain would order out his little crew of two or three men and spend a week in loading up his seventy or eighty thousand feet. Now, the dock jobbers take the loading in hand, and a barge, the style of craft now generally in use, will receive her cargo of 600,000 feet in two or three days. Then, the sum total of rents paid by the dealers was about $7,000 yearly; now the Van Rensselaers derive an annual revenue of more than $80,000 from the same source. Then, the gross sales yearly were about $1,500,000. Now, one single house in the district has sales to that amount. Then, the rule was small stocks and a full assortment; now the dealer generally keeps a large stock and few kinds; and the buyer goes to one yard for pine, to another for hemlock and spruce, to another for his hard wood, and so continues till his wants are supplied. Then, the boats used on the canal for transporting lumber were only capable of carrying about 40,000 feet. Some of the canal-boats now in use can carry a load of 165,000 feet.[2] Then, the dealer felt supremely happy in a little six by nine shanty, furnished with twenty dollars' worth of fixtures, and would consider a man a prodigal who would invest $500 in a structure for business purposes. Now the dealer consults his architect, talks of gothic and Corinthian, levies upon his knowledge of æsthetics, and concludes that a thousand or two either way makes but little difference so that he can have an elegant, commodious office, with all the modern improvements.[3]

The lumber dealers of Albany have a Lumberman's Board of Trade,[4] and various conveniences for their common benefit, including ample provisions against fires, and a chapel for the use, as well of those regularly employed, as of those who may be detained on the Sabbath.

It is difficult to state the amount of the lumber trade of Albany from official statistics. The greater part of the lumber is received by canal, but large quantities are also brought by railroad, especially in the winter season. The actual quantity of material cannot be derived from a report of sales, because the dealers often sell to one another.

The following tables will show the quantities and values of forest products, brought by the Erie and Champlain Canals, to tide-water, and left at different points that are important centers of the lumber trade, through a series of years.

---

[1] *The Albany Lumber Trade; its History and Extent:* first printed in the *Albany Argus*, August 15, 1872.

[2] The locks of the enlarged Erie Canal pass boats 110 feet long, 18 feet wide, and drawing 7 feet of water. On the Champlain Canal they admit boats 100 feet long, 18 feet wide, and drawing 5 feet of water.

[3] The writer mentions several firms having luxurious establishments for offices, one for example, 32 by 42 feet of gothic style, the walls and ceiling being black walnut and ash, the floors of Georgia pine, and the furniture the best that could be had. The office, with fire-proof vault, bath-room, etc., had cost over $7,000.

[4] Incorporated May 8, 1869.

Boards and scantling brought by canal.

Years.	Albany.		West Troy.		Waterford.		Usual price per M feet.
	Feet.	Value.	Feet.	Value.	Feet.	Value.	
1857	180,097,629	$2,881,560	137,218,900	$2,195,502	6,348,802	$63,488	$16 00
1858	267,406,411	4,412,205	142,479,100	2,350,906	12,965,600	129,656	16 50
1859	291,771,762	4,887,178	167,159,300	2,841,708	21,482,500	204,085	16 75
1860	301,022,600	5,042,128	172,575,000	2,890,631	28,490,700	477,218	16 75
1861	162,952,527	2,729,454	93,817,800	1,571,448	17,614,500	295,043	16 75
1862	223,899,027	3,862,258	128,783,700	2,221,519	27,447,200	473,464	17 25
1863	243,611,518	6,090,288	160,979,300	4,024,483	21,743,504	543,588	25 00
1864	255,418,130	7,662,544	136,418,600	4,092,558	21,484,500	644,535	30 00
1865	258,997,965	7,769,938	164,978,000	4,949,340	20,295,200	608,856	30 00
1866	343,508,062	10,305,242	189,610,500	5,688,315	19,728,200	598,460	30 00
1867	382,883,955	11,486,519	195,478,600	5,864,358	19,070,800	572,124	30 00
1868	437,097,000	13,112,910	179,868,200	5,396,046	38,045,498	1,141,365	30 00
1869	444,474,896	12,445,300	165,566,900	4,635,593	62,357,862	1,746,018	28 00
1870	452,363,884	9,499,642	169,364,300	3,556,650	20,616,535	432,936	21 00
1871	421,093,211	11,106,227	182,447,900	4,378,750	22,745,780	545,898	24 00
1872	431,348,741	11,215,067	176,069,500	4,577,807	43,332,682	1,126,650	26 00
1873	325,524,398	7,162,536	121,949,000	2,682,878	27,184,200	598,052	22 00
1874	332,821,000	....	....	....	....	....	....
1875	269,945,000	....	....	....	....	....	....

Shingles.

Years.	Albany.		West Troy.		Waterford.		Usual price per M.
	M.	Value.	M.	Value.	M.	Value.	
1857	71,000	$248,515	16,928	$59,249	305	$915	$3 00
1858	31,823	111,383	13,453	47,086	682	2,046	3 00
1859	48,756	170,647	127,836	447,426	1,333	3,999	3 00
1860	41,222	144,277	19,052	66,682	357	1,250	3 50
1861	31,782	111,237	12,037	42,130	480	1,498	3 50
1862	32,622	114,177	12,601	44,103	807	2,825	3 50
1863	21,223	95,503	10,746	48,356	960	4,320	4 50
1864	24,003	132,017	4,763	26,196	354	1,947	5 50
1865	24,046	120,230	7,433	37,165	252	1,260	5 00
1866	39,594	197,970	10,168	50,840	2,355	11,775	5 00
1867	26,880	134,400	12,645	63,225	2,916	14,580	5 00
1868	37,069	185,345	13,385	66,929	69	345	5 00
1869	32,166	128,664	4,555	18,220	84	336	4 00
1870	21,488	97,529	5,784	26,028	9	41	4 50
1871	27,998	139,990	7,437	37,185	3,000	15,000	5 00
1872	2,602	13,010	7,994	39,970	3,075	15,375	5 00
1873	10,877	54,385	3,483	17,415	308	1,540	5 00
1874	15,600	....	....	....	....	....	....
1875	7,965	....	....	....	....	....	....

Timber.

Years.	Albany.		West Troy.		Waterford.		Usual price per cubic foot at Troy.
	Cubic feet.	Value.	Cubic feet.	Value.	Cubic feet.	Value.	
1857	85,104	$15,318	1,688,524	$303,934	640,518	$76,862	$0 18
1858	119,497	20,314	980,969	166,764	355,350	53,302	17
1859	70,381	11,965	1,358,894	237,807	1,097,386	153,634	17½
1860	46,888	7,971	1,270,867	216,047	943,840	160,453	17
1861	44,754	7,607	716,964	121,884	391,549	66,563	17
1862	148,217	41,501	2,567,914	719,416	778,332	217,933	28
1863	307,701	92,310	2,680,416	804,125	1,540,754	462,226	30
1864	314,995	125,997	2,217,997	887,198	1,587,136	634,854	40
1865	136,174	47,661	2,115,388	740,386	1,470,987	514,845	35
1866	260,619	91,217	1,857,593	643,158	1,986,712	695,349	35
1867	62,705	20,947	2,049,407	717,292	1,257,688	440,191	35
1868	66,700	23,345	1,246,500	436,275	1,104,463	386,562	35
1869	5,000	2,000	1,172,000	468,800	1,974,673	789,869	40
1870	116,750	52,538	1,423,200	640,440	735,661	331,047	....
1871	9,573	4,786	1,292,400	646,200	303,288	151,644	50
1872	2,800	924	1,192,809	393,627	272,113	89,797	33
1873	9,000	2,970	1,059,959	349,786	321,098	105,962	33
1874	7,500	....	....	....	....	....	....
1875	6,807	....	....	....	....	....	....

Staves.

Years.	Albany.		West Troy.		Waterford.		Usual price per pound at Albany.
	Tons.	Value.	Tons.	Value.	Tons.	Value.	
1857	76, 632	$689, 691	10, 602	$95, 410	2, 061	$20, 613	$0. 004½
1858	67, 506	540, 047	10, 223	81, 780	3, 041	2, 433	004
1859	57, 285	458, 282	11, 542	92, 342	2, 328	13, 968	004
1860	74, 368	594, 942	11, 651	93, 211	1, 069	8, 552	004
1861	71, 892	575, 138	8, 282	66, 256	1, 227	9, 812	004
1862	105, 106	840, 848	13, 935	111, 482	1, 783	14, 261	004
1863	73, 373	586, 985	5, 679	45, 429	824	6, 593	004
1864	43, 395	607, 526	4, 479	62, 708	1, 408	2, 817	007
1865	12, 523	175, 317	4, 225	59, 146	1, 065	14, 914	007
1866	13, 954	195, 361	2, 843	39, 802	804	11, 260	007
1867	15, 730	220, 220	5, 476	76, 677	1, 284	18, 033	007
1868	14, 073	197, 021	5, 908	82, 722	661	9, 258	007
1869	4, 403	61, 631	1, 512	21, 173	618	8, (56	007
1870	8, 885	124, 384	1, 426	19, 959	150	2, 182	007
1871	4, 884	78, 149	894	14, 292	82	1, 312	008
1872	3, 940	78, 786	1, 724	34, 486	1, 064	21, 281	010
1873	2, 430	47, 595	1, 694	33, 881	....	....	010
1874	699	....	....	....	....	....	....
1875	688	....	....	....	....	....	....

Besides the above articles, from 4,000 to 5,000 cords of wood have in recent years been left annually at the places mentioned in the headings, chiefly Albany and West Troy, and in about equal quantities at each.

The materials left at Waterford are wholly from the Champlain Canal. The relative amount brought by the Erie and Champlain Canals to the other two places, varies considerably one year with another, but may be stated approximately as follows:

Of boards and scantling.—From the Erie Canal, about three-fifths at West Troy, and from a third to a half at Albany, and from the Champlain Canal the remainder.

Of shingles.—The much greater part by the Erie Canal, although in some years, as in 1873, the Champlain Canal delivered a nearly equal amount at West Troy.

Of timber.—The greater part, in some years the whole, by the Erie Canal.

Of staves.—Much the greater part at both places, by the Erie Canal.

Of fire-wood.—The greater part by the Champlain Canal.

In the absence of data for continuing these tables since 1873, we append the following totals for 1874 and 1875, from the official reports on tolls and tonnage for these years, giving the total of these three places, and the amount going through to New York by the Hudson River.

Statement of property that came to the Hudson River on the canals in 1874 and 1875, with the quantity and estimated value of each article in Albany and Troy.

Articles.	Quantity.		Tons.		Estimated value.	
	1874.	1875.	1874.	1875.	1874.	1875.
BOARDS AND SCANTLING.	*Feet.*	*Feet.*				
By Erie Canal	314, 333, 400	262, 853, 400	623, 889	438, 089		
By Champlain Canal	252, 289, 800	190, 540, 800	420, 483	317, 568		
Total	566, 623, 200	453, 394, 200	1, 044, 372	755, 657	$14, 165, 581	$9, 067, 906
SHINGLES.	*M.*	*M.*				
By Erie Canal	25, 344	15, 416	3, 168	1, 927		
By Champlain Canal	1, 320	4, 864	165	608		
Total	26, 664	20, 280	3, 333	2, 535	119, 987	91, 516
TIMBER.	*Cubic feet.*	*Cubic feet.*				
By Erie Canal	2, 257, 400	647, 600	45, 145	12, 952		
By Champlain Canal	279, 250	....	5, 585	....		
Total	2, 536, 650	647, 600	50, 730	12, 952	1, 141, 491	259, 023
STAVES.						
By Erie Canal	....	....	80, 720	33, 552		
By Champlain Canal	....	....	680	212		
Total	....	....	81, 400	33, 764	1, 627, 997	675, 275
WOOD.	*Cords.*	*Cords.*				
By Erie Canal	740	144	2, 072	3, 480		
By Champlain Canal	3, 774	9, 125	10, 567	4, 842		
Total	4, 514	9, 269	12, 639	8, 322	31, 598	28, 548
ASHES, POT AND PEARL.	*Barrels.*	*Barrels.*				
By Erie Canal	741	....	204	....		
By Champlain Canal	....	164	....	45		
Total	741	164	204	45	46, 683	1, 260
Total forest products	....	....	1, 192, 681	813, 275	17, 133, 337	10, 123, 528
Total of all articles carried	....	....	3, 223, 112	2, 608, 777	107, 976, 476	89, 447, 518

Lumber and timber trade of Tonawanda, N. Y.

Tonawanda, upon the Niagara River, 12 miles from Buffalo, has in recent years become a most important point for the shipment of lumber and timber from Michigan and Canada. The receipts by lake, for the season of 1876, were as follows:

Lumber, feet	207, 728, 327	Logs, feet	15, 592, 061
Lath, pieces	6, 137, 700	Cedar posts, number	16, 150
Shingles, pieces	18, 907, 500	Railroad ties	19, 900
Pickets, pieces	86, 000	Staves	593, 065
Timber, oak and pine, cubic feet	354, 500		

The relative amount received from American and Canadian ports in 1876 was as follows:

	American ports.	Canadian ports.
Lumber, feet	196, 761, 690	10, 966, 637
Round timber, feet	10, 365, 433	5, 220, 628
Square timber, cubic feet	352, 470	2, 030

Comparative receipts during last five years.

	1873.	1874.	1875.	1876.	1877.
Lumber, feet	104, 900, 000	144, 754, 000	155, 384, 805	207, 728, 327	221, 076, 007
Lath, pieces	1, 258, 000	1, 506, 000	6, 559, 200	6, 137, 700	5, 126, 050
Shingles, pieces	1, 112, 000	10, 823, 000	13, 088, 500	18, 907, 500	23, 248, 400

The importation of lumber from Canada was 5,104,000 feet in 1873; 11,385,715 in 1874; 13,650,369 in 1875, and 10,966,637 in 1876.

The shipments of lumber by canal were 89,273,358 feet in 1873; 115,752,111 in 1874; 129,579,796 in 1875, and 165,549,747 in 1876.

In 1876 3,095 cars (average 8,500 feet) or 26,309,500 feet of lumber were shipped by New York Central and Hudson River Railroad, and 1,200 cars or 10,200,000 feet by Erie Railway.

The manufactures of Tonawanda during the year were: Bill stuff, 16,098,000 feet; shingles, 50,784,000; and lath, 3,824,000.

The "Tonawanda Lumberman's Association" was formed July 27, 1875, for the protection and promotion of the lumber and timber trade of that point.

Lumber trade of Buffalo.

Statements of receipts and shipments of forest products, from commercial statements, show the following amounts received by lake and forwarded by canal. The great decline in the latter is partly due to the diversion of the trade to Tonawanda, where ample facilities have in recent years been provided for receiving from the lake and shipping by canal.

I. LUMBER.

Years.	Receipts by lake (feet).	Exports by canal (feet).	Years.	Receipts by lake (feet).	Exports by canal (feet).
1865	109, 168, 398	70, 836, 766	1871	207, 755, 198	141, 648, 046
1866	153, 788, 267	120, 031, 764	1872	204, 976, 754	147, 519, 461
1867	187, 046, 552	142, 190, 804	1873	200, 117, 390	120, 196, 960
1868	208, 047, 862	166, 589, 710	1874	145, 624, 639	80, 081, 776
1869	224, 935, 748	165, 197, 178	1875	153, 355, 824[1]	65, 485, 538
1870	217, 247, 916	168, 204, 218	1876	138, 386, 379[1]	57, 213, 581

[1] Imports by lake and railroads.

Shipped by canal in 1877, from the opening of navigation to November 1, 74,961,117 feet. Receipts by canal, 1,915,448, in 1870; 945,997, in 1871; 1,931,791, in 1872; 839,505, in 1873; 749,400, in 1874.

II. TIMBER.

Years.	Receipts by canal (cub. feet).	Exports by canal (cub. feet).	Years.	Receipts by canal (cub. feet).	Exports by canal (cub. feet).
1867	32, 140	22, 906	1872	8, 112	42, 000
1868	700	236, 421	1873	3, 609	42, 240
1869	23, 379	242, 027	1874	5, 035	13, 993
1870	10, 178	128, 800	1875	....	....
1871	21, 775	67, 250	1876	....	....

III. SHINGLES.

Years.	Receipts by lake (number).	Exports by canal (number).	Years.	Receipts by lake (number).	Exports by canal (number).
1867	17, 268, 275	24, 948, 000	1872	16, 039, 300	21, 175, 000
1868	26, 643, 929	41, 151, 000	1873	16, 387, 750	19, 067, 000
1869	30, 173, 100	40, 635, 000	1874	39, 726, 710	28, 265, 000
1870	36, 081, 156	40, 562, 000	1875	79, 969, 121	30, 780, 000
1871	37, 050, 111	38, 109, 000	1876	29, 827, 000	17, 167, 000

IV. STAVES.—IMPORTS.

Years.	Number.	Tons.	Years.	Number.	Tons.
1865	19, 486, 491	98, 413	1871	22, 897, 310	68, 891
1866	25, 655, 171	124, 000	1872	22, 647, 000	98, 152
1867	26, 659, 875	125, 800	1873	22, 390, 792	92, 572
1868	27, 042, 596	132, 965	1874	24, 349, 645	79, 610
1869	14, 271, 417	77, 980	1875	24, 195, 068[1]	....
1870	23, 488, 322	113, 404	1876	9, 534, 127[1]	....

[1] By lake and railroads.

Cayuga County.—The region eastward from Cayuga Lake, and extending back several miles, taking in the western portion of the south half of this county, rises from the lake (387 feet above tide) by a gradual slope to a height of more than 600 feet at Poplar Ridge, four miles distant from its waters. The soil is a rich strong loam, and has been widely noted for its products of wheat and other crops. The prevailing winds are west-northwest, west, south, and southwest, there being but little from other points. The rain-fall is about 36 inches, but is greater on the high ridges than near the lake.

The sugar-maple was the most abundant tree of the native forest Next, and along the border of the lake, white oak. Basswood was common. Beech was frequently found in abundance on rather flat and heavy, damp soils. White elm grew on lands more moist. Hickory (*Carya alba*) was widely distributed. Red oak (*Q. rubra*) and scarlet oak (*Q. coccinea*) were frequent; also slippery elm, tulip tree, wild cherry (*Prunus serotina* and *P. virginiana*), red and black maple, and hemlock, the latter growing abundantly along deep ravines. The white pine was found occasionally, but little or no chestnut. Of these timber trees the white hickory and sugar-maple were regarded best for fuel. White oak stood highest on the list for durable timber for various manufacturing purposes, and the wood of the tulip tree was highly valued for cabinet-work, and was often used for house-siding. Some of the trees were very large, and all were remarkable for their straight stems. I measured one that was 6 feet in diameter and 124 feet high. By counting the rings of growth, it appeared that it was ninety years old when Columbus discovered America.

In second growths, where permitted, the original sorts are repeated. No forest planting has been done here, and land-owners have slashed away at the original woods without apparently thinking that a race was to come after them. Where trees have been planted in lines they have grown finely, and show how successful shelter-belts would prove. The European larch, on my own grounds, without cultivation, has grown 48 feet high and 16 inches in diameter in twenty years. Other trees grow finely. The tent-caterpillar occasionally denudes trees early in summer, checking the growth; but they nearly all recover their vigor

another year; a few dead limbs remaining.—*J. J. Thomas*, Union Springs, N. Y.

GENESEE COUNTY.—Mr. Henry Ives, of Batavia, Genesee County, New York, in a communication to the New York Farmers' Club in the spring of 1876, states the result of experience in tree planting as follows:

Five or six years ago I planted two acres with four-year old seedlings of white elm and soft maple into forest rows, 16 feet apart and 3 feet apart in the row. Now the best of them are 20 feet high and 12 inches in circumference, and for thinning out the rows I sell trees for more money than wheat would have brought grown for these years, and I can continue to sell so until they are so large that I can take them for fire-wood, and I am growing a good crop of orchard grass between the rows. So that these trees in forest timber are paying as well, and are likely to pay for years to come, as any other acres on the farm. I am cutting now the second crop of wood where the first or original timber was taken off about twenty-five years ago, and last winter 1,000 rails were taken by a neighbor from one-third of an acre of growth, besides a quantity of wood from the top, and timber not making rails. Another neighbor used nice black walnut lumber in building a fine farm house, sawed from the trees that he had helped plant when a boy.

The same writer mentions a soft-maple tree planted in the main street in Batavia twenty-one years before, which measured 19½ inches across inside the bark, which cut 2¼ cords of 18-inch wood. Other trees 17 years old measured 4 feet around at 2 feet from the soil.

The "Big Tree" of Genesee Flats.

An object of noted interest in the "Genesee country" on its first settlement was a white-oak tree which grew some rods from the banks of the Genesee River, in the town of Geneseo, N. Y. The erosion of the current having endangered its existence, General Wadsworth, the owner, spent some hundreds of dollars in trying to save it, but finally in the great flood of 1858 it was undermined, and the next spring it floated some four miles down till it lodged. The general caused sections to be cut and removed to his grounds, where they were placed under cover and still remain, with a reasonable prospect that they will continue to attract the admiration of the curious for generations to come.

The circumference at its base was 33 feet. The diameter of the largest section, taken at 10 feet from the ground, is a little over 8 feet. No record of its height was taken, but it was nearly or quite 70 feet. It was not tall for its size, but at some 20 feet from the ground it put out large branches, five or six in number, which of themselves were of colossal size, being 2 feet and more in diameter. This made a very large bushy top. On the side nearest the river, there came up, as if from the same root, an elm 2 feet in diameter, which twined itself with the oak at the roots and the body of the tree, so that they seemed almost inseparable. This freak of nature attracted quite as much interest as the immense size of the tree itself.—(*Letter of Hon. Hezekiah Allen.*)

JEFFERSON COUNTY was originally well-timbered throughout, but much of the forest has been cut away, and there are, at present, no extensive bodies of timber in one place. The "Pine Plains" consisted of an extensive tract of white pine of dense growth and great value, extending on the north side of the Black River from near Carthage to Le Raysville. This timber has all been cut off, and the light sandy soil has been repeatedly ravaged by fires, so that there is scarcely any organic matter left. A very small tract of this pine extended across the river in the town of Rutland, and one pine tree, under the shelter of the hills, measured 288¾ feet in height. Red cedar occurs only upon islands along the

lake shore, but the top of a hill, in the low level region north of the river, was covered with this timber when the country was new. The level of the lake was much higher in recent geological times than at present, as is shown by the beaches far up on the hill-sides, and it is probable that this flat country was submerged at the time when this hill-top of red cedar was an island in the lake.

LEWIS COUNTY.—Extensive tracts of white pine formerly occupied the broken sandy soil in the eastern part of this county, but most of this, valuable for lumber, has long since disappeared, and the region has been overrun by fires, to the great injury of the soil. There are still extensive forests of hemlock and hard woods in the eastern part, but some eight or ten extensive tanneries are using up the former quite rapidly. The western part of the county is an elevated plateau region, in some places swampy, and here also are extensive forests of birch, hemlock, spruce, beech, maple, &c. The central part has been cleared many years. A line of cedar swamp originally existed many miles along the west side of the river, and a part of this remains. Thrifty groves of young white and Norway pines occur in some places in the eastern part.

A tract of white pine several hundred acres in extent, in the town of Greig, was cut off about 1820. It is now a dense forest, the trees being 12 to 18 inches in diameter, very tall and straight, and valuable for spar-timbers, for which purpose it is being again cut. It is estimated that the white pine in this soil and climate comes to full maturity in eighty to one hundred years, and it is observed that when this period is passed, the decline is rapid, and timber, if neglected, will soon perish.—(*F. B. H.*)

Letter from the Hon. Horatio Seymour, of Utica, Oneida County, N. Y., giving his observations and experience in forest-tree planting.

UTICA, *December* 29, 1876.

MY DEAR SIR: Absence from home and ill-health have prevented me from writing to you before this about forest trees. I have been in the habit of cultivating them for many years, and I have watched their growth with interest. I have raised them both for useful and ornamental purposes.

Of course the kind of tree you select must depend upon the object you have in view. Of our native trees the best for ornamental purposes are the elm, the basswood, the white pine, and the hemlock, and sometimes the maple. The last should never be put in streets or places exposed to horses, &c.

The bark of the young tree is thin, and if it receives any hurt or injury it will never get over it. It may live for a number of years after it is hurt. But in the end the inside wood will rot, and it will either break off from the winds or slowly perish. It is also liable to be attacked by the borer and other enemies. I know that more maple trees have been set out in the city of Utica than stood upon its site when it was a wilderness. Yet I do not know of a healthy tree of the kind that has reached any size. It is strange that people will continue to set out this tree in streets and exposed places in the face of these results.

The elm is a fine tree for ornamental purposes, but it sometimes sends its roots out too far and becomes hurtful to yards and gardens. The basswood is a fine tree, with clean, fresh foliage, and it will outlive almost any injury. As you know, it will grow when the inside is so hollow that they are sometimes cut down to be used for leach-tubs. The ash grows slowly, puts out its leaves late in the spring, and loses them early in the fall.

The finest evergreens for ornament are our own white pine and hemlock. None of the foreign varieties will compare with them. They are graceful in their forms and foliage, and are more admired by Europeans than any of the trees of this country.

The Norway spruces are miserable affairs, and can be rarely used with a good effect. They grow rapidly when young, but become ragged and thin when they get to be any size. Their effect in groups is bad, as their sharp tapering tops give them a weak, ineffective aspect. We have a great variety of minor trees, such as the striped maple, with its green and black bark. The mountain maple, with its great bunches of scar-

let seed-vessels, which should be introduced into groups on lawns and ornamented grounds.

Our American shrubs and minor trees have been too much neglected.

I should state here that while it is somewhat difficult to move the pine and hemlock, yet if they once take root, if they are highly manured, they will grow with great vigor.

Forest trees to be raised for profit.—When it is proposed to raise trees for profit, regard must be had to climate and soil. Many which are vigorous in Central New York do not grow well upon the sea-coast, and it may be they would not be suitable for the Western States.

I speak of the results I have seen in the county of Oneida. On the farm on which I live, about forty acres of woodland were cut over twenty-five years ago. The trees were allowed to grow up again from the seeds which were in the ground. They did not grow from the stumps, but were all new growth upon their own roots, and started at the same time. The tree which outstripped the others is the soft-shell or pig-nut walnut. The next in size is the black cherry, and then comes the basswood; then the elm, the ash, the maple, the birch, and the beech, in the order I have named. The walnut and the black cherry are not only the largest, but most valuable trees in other respects. Their wood is heavy and firm, and they are useful for carriage and cabinet makers as soon as the trees are a foot in diameter. None of the forest trees in this section will bring as large a price as these in market. There is also a great advantage in the form of their growth. They usually grow up with a single stem, even when they stand in open grounds.

This gives to the trunk of the tree more length and value. If the maple or the birch or the beech stand where they can take their natural forms after they have grown to the height of ten or twelve feet they will divide into a great number of small branches. So that while the trunk may be two feet in diameter for a short length, above that the numerous branches will be of no value in the arts and not of great value as fuel. When the trees grow compactly of course they will all be inclined to grow with a single stem. But the walnut and the black cherry will still be much the most valuable. The hickory nut does not grow upon my land. The ground of which I speak is mostly clay mixed with gravel.

I find that the black cherry grows equally well upon this ground and upon sandy soil if it is not too dry. It will grow readily from the seed and so will the walnut. I find them springing up in my grounds where the pits and nuts have been carried by birds and squirrels.

I think the European larch can be raised here with great advantage. Those I have planted have grown rapidly with a single stem. I think they are valued in Europe for the durability of their timber. I do not know how they will prove in that respect in this country. The small seedlings can be got at reasonable prices, and if they are taken care of when young they will make fine trees as soon as any variety I have ever cultivated. They will grow well on sandy soil. They have some beauties as an ornamental tree. In early spring their smaller limbs take the yellow color which marks the willow.

Unlike their cousins, our tamaracks, their foliage is soft and abundant. Their limbs are flexible and graceful, and drop down long slender branches which wave very beautifully in the winds. Its foliage in autumn turns to a rich golden yellow and remains long after other deciduous trees become bare.

I am, truly yours, &c.,

HORATIO SEYMOUR.

Dr. FRANKLIN B. HOUGH,
Lowville, N. Y.

Results of tree-culture at Hamilton College (Clinton, Oneida County), New York.

A park of fifteen acres is connected with this college, and in 1853 the committee in charge resolved to obtain specimens of every tree and shrub supposed to be hardy in the climate of Central New York. A pinetum was begun, and a large variety of conifers has been planted.

Labels have been affixed to many of the rarer trees and shrubs, showing the botanical and common names, and habitat. The curators of the grounds are Prof. Oren Root, John C. Hastings, and Rev. Dr. A. D. Gridley. The list is printed annually with the college catalogue, and the one for 1876–'77 gives the names of 94 species of deciduous trees, 34 evergreens, and 61 shrubs that had proved hardy and desirable. Among these were a considerable number of exotic species.

SCHUYLER COUNTY.—In the autumn of 1804, Alexander Wilson, the ornithologist, made a journey on foot from Philadelphia to Niagara, passing up the Susquehanna Valley, and by the way of Seneca Lake to Oswego. His adventures were related in a poem, entitled "The Foresters," in which he described the magnificent white-pine forest then growing in the summit valley that extends from the Chemung River to Seneca Lake. It is of historical interest, as showing the impressions made by a forest apparently inexhaustible, but which did not long survive the completion of the Chemung Canal through the valley in 1832-'33. The last vestige, as standing timber, disappeared about 1845.

Now dark before us, gulfs of pine are seen,
That bear the name still of their Indian queen;
Great Catherine's swamps their deepening round extend,
Down whose dun gloom we awefully descend;
Around us thick, the crowding pillars soar,
Surpassing all we ever viewed before,
So straight, so tall, so tow'ring side by side,
Each, in itself, appears the forest's pride;
A thousand fleets, with twice ten thousand more,
May here find masts in everlasting store;
Here melancholy monks might moping dwell,
Nor ray of sunshine ever reach their cell,
Through the dread twilight reigning horrid here,
In holy groans their relics sad revere.
Great solitary shades! so still and deep,
Even passing sighs in hollow murmurs creep!
The silence deep, the solemn gloom profound,
The venerable piles that rise around,
Such awe inspire, that as we upward gaze,
In whispers low, we murmur our amaze.

QUEENS AND SUFFOLK COUNTIES.—*General remarks relating to the woodlands of Long Island.*—The soil of the island differs greatly in quality and material. The hilly region along the middle part is largely of unmodified loamy drift. The north side next to the sound is of similar material. The south side next to the bay and ocean is more sandy, and is a plain, gently sloping to the ocean. That part of this plain in Suffolk County is largely covered with the pitch-pine (*Pinus rigida*), hard woods occurring in many places.

In relative abundance, the trees may be arranged as follows: The oak family is much the most numerous; then the hickories, chestnut, and locust, which together form the bulk of the woodlands, and grow with great vigor in all the loamy districts. The following trees are common, but are not so abundant as to form a prominent feature in the forests: Tulip, sweet-birch, sugar-maple, linden, white-elm, cherry, black-walnut, beech, larch, and eminently the white-pine, balsam, poplar, and white birch. Of the oaks, the white, red, and yellow-bark are about equally common. Of the hickories, the white is most abundant. The sassafras would, with a little protection, become very abundant, but is hunted for its crooked branches and roots, and scarcely a farmer forbids it.

The average height of our forests, when forty to fifty years old, is about 70 feet. They are usually cut at that age, and on poor soils would, at fifty years, be not over 60 to 65 feet. The chestnut grows to a great size; sometimes 5 or 6 feet in diameter at 3 feet from the ground. The white-oak also grows to a large size. The pitch-pine forests cover thousands of acres of the sandy land of Suffolk County, growing slowly, and almost to the edge of salt water. It is mostly sold as cord-wood, only the large trees containing pitch in the heart wood. The white-pine, once abundant, is now limited to one or two small forests, but would

grow splendidly if set out for forest growth.—(*Elias Lewis, jr.*, Brooklyn, N. Y.)

The south side of Long Island is low, and elevated but a few feet above the sea. It is mostly sandy, but in some parts very fertile. The north side is rough, ranging from near sea-level to 200 feet above sea-level. The native trees are oaks of various species (*Quercus alba*, *Q. corimea*, var. *tinctoria*, *Q. obtusiloba*; pitch-pine, hickories, *Carya microcarpa*, and *C. tomentosa*), and red cedar, which occur throughout the whole island. The locust, tulip, poplar, white-elm, and chestnut, which are common in Queens County, become less eastward, to River Head, 70 miles from New York, but east of this do not grow. The locust is destroyed by a borer, which, of late years, is also working on the native trees in other parts of the island. The oak, if left to proper age, would be suitable for ship-timber, but is usually cut when thirty years old for cord-wood. The pine is also cut for fuel, but sometimes for charcoal. Hickory is chiefly used for wagon-making.—(*Edwin S. Miller*, Wading River, N. Y.)

TIOGA COUNTY.—This county is generally hilly, except the narrow valley of the Susquehanna, and of several tributaries. These valleys are about 800 feet above tide, and the hills from 500 to 700 feet higher. In clearing lands of hemlock, beech, birch, maples, white oak, chestnut, and several other hard woods, the succeeding growth, if allowed to come up, is pine, hemlock, sugar-maple, black birch, and beech, all of the former kinds, and especially the sumac and quaking asp. The latter is frequently killed by borers, after getting from 30 to 45 feet high, and 6 to 7 inches in diameter. The wood is bored in every direction. Several indications show that if this country were abandoned, it would in fifty years be a dense wilderness. White pines will sometimes get started in fields, and we have a number of second-growth pine groves 35 to 45 years old, now large enough for 2 to 3 saw-logs to each tree. We have no evidence of a change of climate since settlement, except the failure of streams. We have no greater droughts than we had when the country was three-fourths wooded, I remember seeing when a boy a more severe drought than at any time since. There has been no forest planting, but every year more or less clearing, the timber being cut off and burned.

Some 55 or 60 years ago, a high hill 3 miles south of this in Windham, Pa., was covered with large hemlock trees, that were all killed in one year by the worms, to the amount of hundreds of acres. Some years ago the hemlock was killed in patches over two or three towns, by a kind of caterpillar that ate off the leaves, so that the trees died.—(*Robert Howell*, Nichols, N. Y.)

WEST CHESTER COUNTY.—The late Horace Greeley, in speaking of the available opportunity for timber-culture in this county, remarked:

> I am confident that ten thousand acres might to-morrow be given back to forest with profit to the owners and advantage to all its inhabitants. It is a fruit-growing, milk-producing, truck-farming county, closely adjoining the greatest city of the New World; hence one wherein land can be cultivated as profitably as almost anywhere else. Yet I am satisfied that half its surface may be more advantageously devoted to timber than to grass or tillage. Nay, I doubt that one acre in a hundred of rocky land—that is, land ribbed or dotted with rocks that the bar or the rock-hook cannot lift from their beds, and which will not, as yet, pay to blast—is now tilled to profit, or ever will be until it shall be found advisable to clear them utterly of stone breaking through or rising within two feet of the surface. The time will doubtless arrive in which many fields will pay for clearing of stone that would not to-day. These, I urge, should be given up to wood now, and kept wooded until the hour shall have struck for ridding them of every impediment to the steady progress of both the surface and the subsoil plow.
>
> Were all the rocky crests and rugged acclivities of our county bounteously wooded

once more, and kept so for a generation, our floods would be less injurious, our springs unfailing, and our streams more constant and equable; our blasts would be less bitter, and our gales less destructive to fruit; we should have vastly more birds to delight us with their melody, and aid us in our not very successful war with devouring insects; we should grow peaches, cherries, and other delicate fruits, which the violent caprices of our seasons, the remorseless devastations of our visible and insect enemies, have all but annihilated; and we shall keep more cows and make more milk on two-thirds of the land now devoted to grass than we actually do from the whole of it. And what is true of West Chester is measurably true of every rural county in the Union.—(*What I Know of Farming*, p. 51.)

NEW JERSEY.

An extensive tract in the eastern part of this State has a light, sandy soil, not adapted to agriculture, but profitable for the growth of timber, if it were not for forest fires. An account of the damages done by these will be found on page 156. This State has long ceased to produce any forest products for the markets of noticeable amount, besides fire-wood and some of the minor products.

Buried cedar timber in Southern New Jersey.

An interesting subject, connecting the most recent of geological events with the living vegetation of the present time, is observed in the swamps of Southern New Jersey, where there are manifest evidences of a gradual subsidence of the country and the slow encroachment of the sea.

An enormous quantity of white cedar timber (*Cupressus thuyoides*) is found buried in the salt marshes, sound and fit for use, and a considerable business is carried on in mining this timber and splitting it into shingles for market. In some places it is found so near the surface that fragments of the roots and branches are seen projecting above the marsh, while in other cases the whole is covered with smooth meadow sods, and there is no indication of what is beneath till it is sounded by thrusting a rod down into the mud. It is most commonly found on the headwaters of streams. West Creek, East Creek, Dennis Creek, Great Cedar Swamp Creek, and their small branches have cedar swamps through their whole lengths.

The timber which is buried in the swamps undergoes scarcely any change, and trees which have been buried hundreds of years are as sound as ever. It would seem that most of the timber which ever grew in these swamps is still preserved in them. Trunks of trees are found buried at all depths, quite down to the gravel, and so thick that in many places a number of trials will have to be made before a sounding-rod can be thrust down without striking against them. Tree after tree, from 200 to 1,000 years old, may be found lying crossed one under the other, some partly decayed, as if they had died and remained standing a long time and then been broken down. Others had been blown down, and some had continued to grow for a long time after falling, as known by the heart being much above the center, and by the wood on the under side being hard and *boxy*.

The trees lie in all directions, as if fallen at different times, and their united ages, as shown where trees have grown since others had fallen, amounts to some thousands of years. The process of *mining* this timber is as follows: With an iron rod the swamp is sounded till it hits what is thought to be a good log. Its length and size is determined by the rod, as near as may be. A hole is dug with a sharp spade down to the log, and a chip obtained, which, by its *smell*, shows whether it was a

windfall or a *breakdown.* If the former, it was probably sound when it fell and has since remained so. If thought worth working, the matted roots are cut away, the log is sawed off, and when loosened it at once floats in the water, which is always near the level of the swamp. Logs are sometimes worked, though rarely, to a length of thirty feet.

These logs come up with as much buoyancy as newly-fallen cedar, not being in the least water-logged, and the bark on the under side is quite fresh. The under side is always lightest, and turns up in rising to the surface. The workmen go over the same ground again and again, and find new logs each time, the lower logs probably rising in the mud when the roots over them are cut loose, and the logs which had laid on them are removed. These logs are found not only in the swamp, but also out in the salt-marsh beyond the living timber, and are worked below present tide-level.

Most of this business is carried on in the neighborhood of Dennisville, and in some instances the industry has proved quite profitable. These facts may suggest researches in other regions favorable to the preservation of timber in swamps, but where its presence in profitable quantities has not hitherto been suspected.[1]

BURLINGTON COUNTY.—Mr. Charles Stokes, of Rancocas, Burlington County, New Jersey, now in his eighty-seventh year, and who has spent his whole life in that section of New Jersey, writes that he has seen great changes in the forest, but no perceptible changes of climate, his conclusions being "that seasons differ, but nature repeats itself, as is said of history." With respect to change in forest growth, Mr. Stokes remarks that the native timber-trees consisted mainly of oak, hickory, walnut, chestnut, gum, maple, and red and white cedar, tulip, poplar, &c. The oaks were the white, black, red, chestnut, peach or willow, turkey, pin and Spanish oaks, and mostly of large size and excellent quality. The pine was the yellow and swamp varieties, which formed nearly or quite half the forests of the eastern part of the State bordering upon the sea:

About the beginning of the present century were seen, along the shore of the Delaware River, another description of pine, called "spruce" (*Pinus inops*), which has spread extensively in an easterly direction, by the seed being wafted by the westerly winds; and in many places where lands have been worn out under the former system of exhaustive farming, the spruce pine has taken possession, and grown in an astonishing manner; at first so thick as to be almost impenetrable for man or beast. In a short time, however, the weaker part would die out, and so continue to thin itself, while the stronger would increase in height, and in a few years be fit to cut into cord-wood. When fairly set, I think it will be safe to say it will grow two cords of wood to the acre per year. It is thought to make much better fuel than the native pine, and for framework in buildings it is also superior, being taller and of greater strength. This pine has been propagated both by the seed and also by transplanting when young, as a profitable crop. Sometimes small oaks and chestnuts may be seen among the spruce-pines when they get thinned out by growth, the seeds having been carried, perhaps, by squirrels or birds, and when the pines are cut, they having possession will get the start of the seedling pines, and so grow together, and soon make a most beautiful and valuable forest of tall, slender, and straight timber. I should think if the spruce pine a year old and acorns and chestnuts planted at about the same time on suitable or worn-out land, the prospect might be as good as the above, which has in so many instances proved a success. The red cedar has been extensively spread by birds, especially along fences, and with proper care may be made both ornamental and profitable. The white cedar, that grows in swamps at the head-waters of the rivers emptying into the ocean and

[1] The above is chiefly derived from Professor George H. Cook's *Geology of New Jersey* (1868), pp. 354–361, where further details and several engravings are given, illustrating the mode of mining cedar-timber. (See also *Scheyichbi and the Strand*, by Edward S. Wheeler (1876), p. 111, and *Lyell's Second Visit to the United States*, i, 34.) Mr. Wheeler states that between $9,000 and $10,000 worth of shingles, at $15 per M., have been made near Dennisville in a single year from this buried cedar. The larger logs are sometimes sawed into boards.

Delaware River, have been converted into shingles, lumber, and fence-rails, and when removed the young growth quickly follows, much after the manner of the growth of the spruce-pine, but it takes a longer time to mature. I see but little difficulty in accounting for a different kind of timber taking the place of a growth which has been cut and removed. Most kinds of old ripe timber never sprout so as to make a forest after being felled, giving full opportunity for the spread and growth of the seeds of other kinds brought by birds or otherwise, to vegetate and grow, as well as young trees already started, which may grow without obstruction. As pine stumps do not sprout, their reproduction from their own seed is not easy; but if we cut off a second or *young* growth of oak, we find the succession will invariably be oak. This rule will, I believe, govern in all cases.

The value of the new growth of spruce-pine depends very much upon location and state of growth. In the most favorable conditions, Mr. Stokes estimates the value from \$2 to \$4 on the stump, and the yield at fifty cords to the acre. At the lowest estimate this would give a value of \$100 for the wood, or \$120 for the wood and land. The time of growth before cutting is about twenty-five to thirty years. The estimate upon this basis would be:

Value of land, \$20, at 6 per cent. for 30 years	\$36 00
Taxes	14 00
Total cost of investment	50 00

Profit, \$50, to which might be added \$10 to \$20 per acre, by a proper mixture of chestnut. Mr. Stokes remarks: "I have now in view a few acres of such timber, say of ten years' growth, on land not worth \$20 per acre, which I would value at not less than \$100, were it mine."

PENNSYLVANIA.

In an instrument entitled "Conditions and Concessions agreed upon by William Penn, Proprietary and Governor of the Province of Pennsylvania, and those who are the adventurers and purchasers in the said province," dated July 11, 1681, and intended as a Charter of Rights to the colonists, the following provision was made in reference to the maintenance of timber-supply, which is fully up to the most advanced ideas of modern forestry:

XVIII. That in clearing the ground, care be taken to leave one acre of trees for every five acres cleared; especially to preserve oak and mulberries for silk and shipping.

We are not informed as to how far this order was followed, but it is probable that it had no effect, and that it was not observed in a single instance.

This State, as its name implies, was a forest region when European settlements began, and from an early period to the present time, it has produced from various points within its territory large amounts of timber and lumber, but without regard to reproduction and only by the invasion of some new region as an older one became exhausted. The coal-mines of this State have relieved the forests from the necessity of supplying fuel, to a very large extent; but have at the same time created a demand for timber for mining purposes, in large and increasing amount.

Census of lumber production in Pennsylvania in 1810.

Apparently full returns of the lumber manufacture of this State were made in 1810, it being the only statistics of the kind in the United States that were reported in that year from any of the States, with any appear-

ance of accuracy. It affords an item of much historical interest, and a striking contrast with the present day.*

Counties.	Saw-mills.	Feet of lumber.	Value.	Average number of feet to a mill.	Average value per M feet.
Adams	67	824,000	$7,195	12,300	$8 73
Allegheny	60	841,500	8,415	14,025	10 00
Armstrong	11	550,000	2,750	50,000	5 00
Beaver	32	713,500	7,135	22,297	10 00
Bedford	56	1,372,000	7,232	24,510	5 26
Berks	....	3,805,500	38,055	....	10 00
Bucks	97	2,490,000	37,365	27,670	15 06
Butler	1	100,000	606	100,000	6 06
Cambria	9	100,000	606	11,111	6 06
Centre	45	3,370,000	12,400	74,444	3 67
Chester	189	5,146,000	51,460	27,227	10 00
Clearfield	7	700,000	3,500	100,000	5 00
Crawford	24	400,000	2,424	16,666	6 06
Cumberland	102	450,000	4,500	4,412	10 00
Dauphin	75	1,094,198	10,069	14,589	10 00
Delaware	38	1,660,000	16,600	43,684	10 00
Fayette	82	3,467,000	27,736	42,280	8 00
Erie	16	1,600,000	8,000	100,000	5 00
Franklin	69	2,293,720	20,952	33,243	9 01
Greene	....	....	....	....	....
Huntington	50	1,115,322	7,815	22,306	7 07
Indiana	17	850,000	4,000	50,000	4 71
Jefferson	4	80,000	420	20,000	5 25
Lancaster	123	2,790,500	19,015	22,687	6 81
Luzerne	84	5,800,000	46,400	69,476	8 00
Lycoming	40	3,370,000	12,400	84,250	3 68
McKean	4	554,600	2,773	138,650	5 00
Mercer	27	553,000	4,148	20,481	7 50
Mifflin	54	1,250,000	7,813	23,148	6 25
Montgomery	55	1,383,000	11,512	25,109	8 40
Northampton	55	2,032,000	20,320	40,219	10 00
Northumberland	115	6,540,000	38,674	56,879	5 91
Philadelphia	17	3,090,000	61,100	18,177	19 77
Somerset	44	794,000	4,764	18,045	6 00
Tioga and Potter	11	660,000	6,300	60,000	5 00
Venango	12	668,800	6,688	55,733	10 00
Warren	24	5,030,000	25,150	20,958	5 00
Washington	65	2,174,000	17,392	33,446	8 00
Wayne	52	1,040,000	17,565	20,000	16 88
Westmoreland	68	2,190,000	20,950	32,206	9 56
York	94	895,000	7,331	9,521	8 19
Total	1,995	73,747,640	606,530	37,016	8 22

Comparing these returns by regions, we find east of the Susquehanna, in the counties of Berks, Bucks, Chester, Dauphin, Delaware, Lancaster, Montgomery, Northampton, and Philadelphia, 649 mills, and a production of 23,491,198 feet, or about 30 per cent. of the whole quantity; in Northumberland County, at the junction of the two main branches of the Susquehanna, 115 mills, making 6,540,000 feet; on the east branch of that river (Luzerne County), 84 mills, making 5,800,000 feet; on the west branch (Lycoming County, now the great center of this business), 40 mills, making 3,370,000 feet; along the northern border (Erie, McKean, Tioga and Potter, Warren and Wayne), 107 mills, making 8,884,000 feet. On the Juniata and its head waters (Bedford, Cambria, Centre, Clearfield, Huntington, and Mifflin), 221 mills, making 7,907,322 feet. West of the Susquehanna, near the southern border (Adams, Cumberland, Franklin, and York), 332 mills, making 4,462,720 feet, and in the western part on waters tributary to the Ohio (Allegheny, Armstrong, Beaver, Butler, Crawford, Fayette, Indiana, Jefferson, Mercer, Somerset, Venango, Washington, and Westmoreland), 447 mills, making 13,381,800 feet.

Lumber production of Pennsylvania.

In a report made by the State Board of Centennial Managers,[1] the following statements are made concerning the timber resources of this State:

Pennsylvania at an early day became prominent in the production of lumber. The pine forests of the Susquehanna region have long been drawn upon for contributions to the lumber wants of the country, the supply thence obtained, being rafted down the Susquehanna River, either sawed or in logs, to eastern markets. Later, the extensive pine forests of the Allegheny Valley were invaded, and Pittsburgh, by means of the rafting facilities afforded by the Allegheny River, became a great lumber market, supplying the Ohio and Mississippi Valleys with best quantities of pine lumber. Other sections of the State, as well as the two prominent sections above mentioned, have also long furnished considerable supplies of hard-wood lumber, such as walnut, maple, cherry, hickory, and oak. Since about 1850, the manufacture of shooks, for use in the West India sugar trade, has been an extensive branch of the lumber interest of Pennsylvania, the oak timber required being principally found on the eastern and western slopes and on the summit itself of the Allegheny Mountains. Although a large part of the Allegheny Valley has been almost denuded of its pine forests, and some portions of the Susquehanna lumber region have shared a similar fate, it may be said that the State is still heavily timbered, and that many years must elapse before its forests will disappear.

A more detailed account of the lumber business of the Allegheny region is given by Mr. Samuel P. Johnson, historical sketch of Warren County, in *Egle's History of Pennsylvania*:[2]

Almost the exclusive occupation of the first settlers was the manufacture of pine lumber. This continued, with some exceptions, for the first twenty years. Still, very early in the century, necessity compelled the cultivation of the soil to some extent, even by the lumbermen. * * * The northern part of the county, generally covered with hard wood, beech and maple predominating, was found to be well adapted to both grazing and grain-raising. * * * The lumbering business, commenced nearly with the present century, exhibited its infancy and primitive character, for many years, in water-mills and single upright saws, driven by overshot or flutter wheels, working only at certain stages of water, and subject to suspension by ice, flood, and droughts. A mill that could cut 100,000 feet per annum was considered a good investment. Floating lumber to market in rafts was commenced by Daniel Jackson on the Conewango, and by Darius and Joseph Mead on the Brokenstraw in 1801. For halting and tying up rafts, halyard and hickory-splint cables, were mostly used for several years, the latter being manufactured by George Gregg, on the Brokenstraw.

In 1805, a new trade sprung up in the boating of seasoned lumber from the Brokenstraw to New Orleans. * * * Such lumber brought there $40 per thousand feet. From this small beginning the lumber business * * * acquired huge dimensions, until at the spring-time freshets these streams would seem almost covered for miles with floating rafts. Pittsburg, Wheeling, Cincinnati, Louisville, Saint Louis, and other intermediate towns had grown up in the mean time, and opened their markets for lumber. Reäction-wheels, steam-mills, circular and gang saws had superseded the flutter-wheel and the lonesome single saw, and millions of feet were now made where thousands were before.

This business reached and passed its summit between the years 1832 and 1840, when it took a downward grade, and has now by the failure of the timber dwindled to a mere fraction of what it was. * * * Perhaps the most important branch of manufacturing industry of modern growth are the tanneries that within a few years have discovered and commenced to utilize the immense forests of hemlock that covered large portions of the county, especially that part east of the Allegheny River. Six large tanneries and several small ones have recently commenced the consumption of hemlock bark, and are making sad havoc of the native deer-parks. These establishments require large investments of capital, and are now one of the most important and successful industries of the county.

The white pine of Pennsylvania, was somewhat limited to specific ranges and elevations, and was found growing to great size in the northern and central portions of the State. Potter County was peculiarly

[1] *Pennsylvania and the Centennial Exposition* (1878), vol. I, part ii, p. 155.
[2] *Illustrated History of Pennsylvania* (1876), p. 1135.

well timbered, and that region around the headwaters of the rivers, but the best of this has been lumbered off, much of it going by canals to Albany. Another tract in Elk County, covered the divide between the Sinnamahoning and the Clarion. This timber was sometimes of great dimensions, and sometimes dividing near the root, doubtless from some accident by reason of snows, or from loss of terminal bud from insects or other cause, so that the two trunks grew from one root. A single tree is described from this region that made 13,100 feet of lumber. Another range of white pine lay west of the Delaware, northward from Lackawaxen, and between the Lackawaxen and Panpack Creek, in Wayne and the northern part of Luzerne, Wyoming, and Sullivan, along the region drained by the North Branch of the Susquehanna, but this has been mostly cleared off. The principal pine district now worked is on the West Branch and its tributaries, the production from whence, from 1851 to 1876, inclusive, is estimated to have been about six billion of feet. This vast amount represents an area of about 2,100 square miles.

The rafting business upon the Susquehanna began about 1807, when two brothers named Phelps conducted the first raft of spars down from Owego, N. Y., and sold for 25 cents per cubic foot. The business has continued till the present day, but is declining in importance every year. The best days of rafting in this river were from 1833 to 1840, when the amount was several times greater than at present.

From 2,000 to 2,500 rafts of hewn timber are started every year from the headwaters, and 1,000 to 1,200 and sometimes 1,500 reach tidewaters. They will average 6,000 cubic feet to the raft. There are also a few spar rafts. The principal distributing point is at Port Deposit, in Maryland, on the east side, and not far from the mouth of the river. The largest part goes to Philadelphia, and the next largest to New York, the rafts being towed through the canals. Baltimore and other markets receive the rest.

In former days a great number of board-rafts came down with the spring floods. They contained about 54,000 feet, board measure, but now with increased facilities 65,000, 70,000, and even 80,000 feet can be floated on one raft. About 20,000,000 feet of boards, manufactured in mills above, are brought down every year in rafts and boats, and distributed at Port Deposit, and from seven to nine millions at other points. But few shingles are brought down, but about 2,000,000 Michigan shingles are brought annually to Port Deposit for distribution with timber and lumber, to various markets. Formerly large amounts of staves and heading were brought down upon rafts, but now the amounts are much reduced, and they are brought in boats.

In the spring of 1873 an ice dam was formed near Port Deposit, which did a vast amount of damage to the property of the place, and to the lumber business of that season, the effects of which are still felt.

It may not be unprofitable to notice how prices have changed at Port Deposit since an early period of the lumber trade.

From 1833 to 1835 the average price of common pine lumber was $7 to $8 per thousand feet, the highest being about $10.50. Now boat-lumber averages about $22. The best grades, then $18 to $20, are now $35 to $42.

Square pine timber, then worth 5 to 8 cents or sometimes 10 to 12 cents the cubic foot, now sells at 16 cents, and in 1873 it was 20 to 25 cents. White-oak hewn timber, then 12 to 14 cents, is now 20 to 22; and in its highest rates of 1871–'72, it was 30 to 35 cents.

The West Branch Canal was finished October 15, 1835, and opened

an active business in the lumber trade along its route, which continued till the money crisis of 1837.

The lumber business began at Lock Haven about 1850, and at Williamsport about 1852. Phelps & Dodge began at Pine Creek in 1849. At the beginning of 1866 there were 30 mills at Williamsport, with 1,229 saws, and employing 763 men. The capacity of these mills was 995,000 feet; 84,000 shingles, 187,000 lath, and 24,800 palings a day of twelve hours. At the beginning of 1876 there were 26 mills, with a capacity of 316,000,000 feet per annum.

This region has since maintained its prominence in the maufacture of lumber, as will be seen from the following statements:

Shipments of lumber from Williamsport, Pa., since 1869.

	Feet.		Feet.
1869	186, 676, 850	1874	236, 806, 289
1870	250, 764, 078	1875	185, 131, 421
1871	269, 863, 392	1876	179, 298, 191
1872	198, 506, 702	1877	185, 925, 393
1873	243, 462, 489	Total in nine years	1, 936, 434, 805

The production in 1875 was 39,501,000 at Lock Haven, 17,743,695 south of Troy, 9,240,515 at Renovo, and 2,990,434 at Larry's Creek, making 254,657,065 for the whole valley. The loss by fire in 1875 was reported at 2,000,000 feet.

The season capacity for day sawing at Williamsport is 382,000,000 feet a year, and at Lock Haven 71,000,000. The number of establishments and kinds of saws used are as follows:

		Williamsport.	Lock Haven.	Sum of preceding.
Number of lumbering establishments		27	8	35
Kind of saws used	Gang	58	10	68
	Circular	10	3	13
	Mulay	33	8	41
	Gang-edgers	26	9	35

The West Branch Boom Company of Lock Haven was organized March, 1849, and has a capacity of 72,000,000 feet. The Sunbury boom, built in 1872 and remodeled in 1873, was constructed by lumbermen at Williamsport as a protection against accidents at high floods, and has a capacity of 100,000,000 feet.

The West Branch Lumbermen's Exchange was incorporated under an act of the legislature in March, 1872, and has its office at Williamsport.

Lumber rafted out of the Susquehanna boom, at Williamsport, Pa., since 1862.[1]

Years.	No. of logs.	Feet.	Average feet in log.	Years.	No. of logs.	Feet.	Average feet in log.
1862........	196, 953	37, 853, 621	193	1871.......	842, 129	166, 661, 181	198
1863.......	405, 175	76, 475, 826	188	1872.......	1, 484, 103	297, 185, 652	200
1864........	511, 549	96, 595, 681	189	1873.......	1, 582, 460	318, 342, 712	201
1865........	379, 392	72, 421, 468	191	1874.......	989, 586	180, 734, 382	183
1866........	615, 373	118, 831, 494	193	1875.......	1, 096, 897	210, 746, 956	192
1867........	833, 388	163, 196, 511	195	1876.......	....	134, 396, 293[2]	....
1868........	853, 663	165, 338, 389	193	1877.......	....	106, 944, 257[2]	....
1869........	1, 080, 511	223, 060, 305	206				
1870........	1, 099, 777	225, 180, 973	204	Total...	11, 970, 956	2, 573, 965, 701	....

Comparative production of lumber in the Susquehanna Valley in 1876 *and* 1877.

	1876.	1877.
Williamsport	179, 298, 191	185, 925, 393
Lock Haven	29, 915, 000	34, 681, 000
South of Troy	16, 688, 450	15, 1 2, 200
Larry's Creek........	2, 332, 906	2, 477, 985
Renovo	5, 317, 070	2, 795, 820
Total	233, 551, 617	240, 982, 398

Comparative amount of lumber shipped from Williamsport, Pa., during the last two years.

	1876.	1877.
Philadelphia and Erie Railroad	68, 695, 000	65, 369, 800
Catawissa Railroad	63, 148, 315	69, 244, 250
Canal	47, 454, 876	51, 311, 343
Total	179, 298, 191	185, 925, 393

Estimated quantity of standing timber in Pennsylvania (1873).

A report made to the National Lumberman's Association, at Saginaw, in 1873, by G. W. Lentz, of Williamsport, from a committee previously appointed, showed the following estimated quantities of standing white-pine timber, in board measure, in the several lumber districts of Pennsylvania:

	Feet.
	300, 000, 000
Pine Creek and its branches	130, 000, 000
Young Woman's Creek	75, 000, 000
Kettle Creek and its branches	15, 000, 000
Cook's Run	75, 000, 000

[1] The Susquehanna Boom Company was incorporated by special act March 26, 1846, for constructing upon the West Branch of the Susquehanna, between Williamsport and the mouth of Quineshehocque Creek, such structures as might be necessary for stopping and securing logs, masts, spars, and other floated timber. Various supplements to the original bill have been passed, and much litigation and angry controversy has arisen between the company and those using its privileges, chiefly with reference to the rates of toll that should be charged upon logs secured and sorted by the company. The capital is $750,000; shares, $100. The original capital was $10,000. There was no organization effected until November 5, 1849, and no boom finished till 1851. A rival boom company was started at Loyalstock, below Williamsport, but the two companies were consolidated in 1858. In 1860 the boom was broken by a flood, and logs amounting to 50,000,000 feet were lost. In September, 1861, the failure of a dam at Lock Haven occasioned another large loss. The ice in 1868 tore away 24 cribs, and other losses have occurred from time to time. The structure consists of a series of piers, 20 by 40 feet, placed 100 feet apart, made of cribs of timber filled with stones, and carried of this size to the level of low water. The side up-stream is then made sloping, so that the cribs are 20 feet square at the top, and 20 feet or more above the usual level of the river. Between these piers timbers are secured, which, rising or falling with the river, hold whatever logs there may be contained. At the receiving basin the logs are sorted and floated down to the mills. There are now about 400 cribs and 10 miles of boom.—(*History of the Susquehanna Boom Company from* 1846 *to* 1876—*pp.*, 11.

[2] The secretary of the company in reporting these quantities remarks that they simply represent *what passed through the booms.* In addition to this, there was a large amount each year brought down the canal from Lock Haven, and delivered to mills at Williamsport, of which he had no official report. He estimated that this would increase the amount manufactured at their various mills during the season of 1877 to about 200,000,000 feet. We have not at hand the means for determining whether the preceding amounts require a like modification.

	Feet.
Hunt's Run	50,000,000
First forks of the Sinnimahoning and branches	30,000,000
Anderson's Creek and branches	150,000,000
Susquehanna River and small branches	300,000,000
Clearfield Creek and branches	100,000,000
Moshannon Creek and branches	100,000,000
Driftwood and branches of Sinnimahoning	50,000,000
Musquito Creek, below Clearfield	225,000,000
Wickoff Run	60,000,000
Baker and other runs	75,000,000
Beech Creek, &c	50,000,000
Other small streams	515,000,000
Total on all streams east of the Alleghanies	2,300,000,000
Total on all streams west of the Alleghanies	1,000,000,000
Total white pine	3,300,000,000
Hemlock in Pennsylvania	7,000,000,000
Hard-woods fit for saw-logs	4,000,000,000

Statements have been published, numerously signed by owners of timber lands and operators in lumber, to the effect that the amount of pine on the Susquehanna and its tributaries does not exceed 2,500,000,000 feet. The reader must form his own judgment upon the reliability of these statements by interested parties.

VIRGINIA.

A recent survey of this State and its resources[1] divides the State into six natural regions, each of them being well defined by topographical features, and to a considerable extent by similarity of geological formations, soil, surface, natural timber products, and capacity for agricultural productions. Their leading characteristics are as follows:

1. TIDE-WATER VIRGINIA is the eastern and southeastern part, bordering 107 miles on North Carolina and 120 miles on the Atlantic, and by an irregular line of 150 miles along the west on the Middle Country. It is in an irregular quadrilateral, averaging 114 miles in length from north to south, and 90 in width from east to west, with an area estimated at 11,350 square miles, including 2,500 miles of valuable tidal waters. It is everywhere penetrated by bays and tidal waters, with 1,500 miles of shore-line, and the waters that flow through this region drain some 50,000 square miles. It is divided into nine principal peninsulas and many smaller ones.

2. THE MIDDLE COUNTRY, extending from the head of tide to the foot of the low broken ranges that, under the names of Kittoctin, Bull Run, Yew, Clark's, South West, Carter's, Green, Findlay's, Buffalo, Chandler's, Smith's, &c., mountains and hills, cross the State from the Potomac, near the northeast corner of Fairfax County, southwestward to North Carolina. They may be called the "Atlantic Coast Range." The base of this triangular area is 120 miles on the line of North Carolina, 174 on its eastern side, and 216 on its western, with an area of about 12,470 square miles. It is a great moderately undulating plain, from 150 to 200 feet above tide at the eastern margin, and 300 to 500 along the northwestern. Its forests have much of the evergreen species.

3. PIEDMONT VIRGINIA is a long narrow belt, 244 miles long, stretching across the eastern base of the Blue Ridge from Maryland to the Dan;

[1] *Virginia; a Geographical and Political Summary, embracing a description of the State, its geology, soils, minerals, and climate; its animal and vegetable productions; manufacturing and commercial facilities; religious and educational advantages; internal improvements and form of government.* Prepared and published under the supervision of the Board of Immigration, and by authority of law, 1876, pp. 320. This work was chiefly prepared by Maj. JED. HOTCHKISS, of Staunton, Va.

in North Carolina, varying in width form 20 to 30 miles, and with an area of 6,680 square miles. The surface varies between 200 and 500 on the east, and from 600 to 1,200 on the west side. The Blue Ridge varies from 2,000 to 4,000 feet, its general elevation being 2,500, and its highest point, near Tennessee, 5,530 feet.

4. THE BLUE RIDGE, 310 miles long, for two-thirds of its length is embraced in the Valley and Piedmont counties, which have their common lines on its water-shed. It varies from 3 to 20 miles in width, with an area of nearly 2,500 square miles. It increases in elevation toward the southwest, is generally of a deep blue at a few miles distance, and consists of a series of domes connected by long ridges meeting between the high points in gaps or notches and sending out long spurs in all directions from the general range, more especially on the eastern side, and these again sending out others, giving great variety to the surface and exposure.

5. THE GREAT VALLEY OF VIRGINIA is the belt of limestone west of the Blue Ridge and east of an interrupted range of mountains of various local names on the west. It extends from the Potomac to Tennessee, a distance of 330 miles, of which 25 at the north end are in West Virginia. It is drained by the Shenandoah to the extent of 136 miles, the James 50 miles, the Roanoke 38 miles, the Kanawha or New River 54 miles, and the Holston or Tennessee 52 miles. The elevations are 242 feet at the Potomac, 453 at the forks of the Shenandoah, 1,000 at Port Republic, 1,863 at the Augusta Summit, 706 at the James River, 1,293 at the next summit southward, 825 (?) at the Roanoke, 2,049 at Christianburg, 1,780 at New River, 2,594 at Mount Airy, and 1,678 at the Tennessee line. It is a region of great natural fertility and fine resources. It is remarkably adapted to the growth of wheat.

6. APPALACHIAN VIRGINIA.—This is a mountainous region, with long parallel valleys running from northeast to southwest, separated by long, narrow mountains. In crossing this region to the northwest, one must cross from six to ten of these mountain ridges and as many valleys. In Virginia, this belt is 260 miles long and from 10 to 50 miles wide. The heads of the valleys are 2,000 to 2,800 feet above tide, and the waters often flow both ways out of the depression. There are four principal drainages of this part, the James River, the Kanawha or New River, the Tennessee, and the Big Sandy. This is a pastoral region, its cool, moist air, and fertile soil being finely adapted to the growth of grass.

Woodlands in the several regions of Virginia reported as included in farms in 1860 *and* 1870.[1]

Regions.	1860.	1870.
Tide-water	4, 139, 389	1, 715, 941
Middle	3, 148, 376	2, 347, 076
Piedmont	1, 840, 149	1, 352, 795
Blue Ridge	413, 944	349, 381
The Valley	1, 810, 512	1, 457, 146
Appalachian	1, 708, 987	1, 072, 395
Total	13, 061, 357	8, 294, 734

The whole of Virginia was naturally timbered, and no difficulties are met with, either in soil or climate, in planting trees successfully in every part. In many portions of the tide-water region, where the soil is light,

[1] It would lead to error if supposed that the actual amount of woodlands had decreased in the proportion or to the degree indicated in this table. The difference may probably be ascribed in a great degree to omissions in the returns of 1870. So unsatisfactory, indeed, was the census of 1870, that the enumeration of 1860 was taken as the basis of estimates in the survey above noticed.

the lands could be planted with timber more profitably than any other crop. The survey above cited, makes the following statements concerning the timber resources of the State:

Tide-water has extensive forests of yellow Virginia pine, oak, cypress, cedar, locust, &c., from which large quantities of sawed lumber and timber, staves, heading, hoop-poles, shingles, railway-ties, fire-wood, &c., are constantly shipped, very often from the edge of the forests, since vessels can penetrate all portions of the section, directly to all the seaboard markets of the country. Sumac is here an abundant shrub.[1]

The Middle Region has large areas of superior hard pine, black, white, and other oaks, hickory, locust, persimmon, gum, cedar, holly, and other trees from which much lumber, bark, &c., are produced for market. Sassafras and sumac are plentiful, and the former could be made a staple crop on ridge lands, for the production of oil.

Piedmont has considerable forest lands, with many species of oak and hickory, and of tulip-poplar, black walnut, locust, cedar, chestnut, pine, and other timber trees, but it can hardly be considered a source of supply of timber for exportation, save in a few localities. Sassafras and sumac abound.

The Blue Ridge is mostly covered with forests of white, black, red, and rock oak, hickory, chestnut, locust, birch, some excellent yellow pine, and other trees. This section has furnished great quantities of charcoal for the manufacture of iron from the ores on its western margin, and it will long remain a source of supply as the forests renew themselves rapidly. The timber supply of pine and other woods for the eastern part of the valley is drawn from the Blue Ridge. There is found much valuable hard wood, as hickory and oak, for wagons and agricultural implements. It is yet to become an important source of supply for oak-bark.

The Valley has nearly half its surface covered with a growth of oaks, hickories, and locusts, interspersed with black and white walnuts, and yellow and other pines, having an age of one hundred and fifty to two hundred years. This timber while not the largest, is of very excellent quality, and is suited for many manufactures. The slaty lands abound in sumac.

Appalachia is both *rich* and *poor* in forestal wealth. On the Sandstone Mountain ranges, and in the slate and shale valleys, the trees are small, but the growth is dense, of oaks and other hard woods, pines, &c., good for charcoal, with larger trees in the hollows and more fertile spots. On the limestone ridges and adjacent valleys, as also in the calcareous and some shale valleys, oaks, walnuts, white and yellow tulip-poplars, birches, beeches, locusts, cherries, sycamores, and other timber trees are found to grow to a large size, often several feet in diameter, and to a great height. Only portions of this region have been reached by railroads, and extensive forests of excellent timber remain without means for reaching markets. There are some forests of white pines and other conifers, but these timbers are not abundant as forests in this region. Timber for coaling is abundant, and various medicinal plants grow in the forest shade. Wild fruits are also found in abundance, and some reach the market, either dried or canned. Nuts of various kinds abound in many places.

NORTH CAROLINA.

The State of North Carolina presents a great variety of vegetation, as it occupies a place intermediate between northern and southern, and extends from the sea-coast to the highest elevations found east of the Mississippi. Its flora may be divided into lower or maritime, middle, and upper or mountain districts.[2]

The lower district may be easily divided into three botanical regions. The first includes only the line of sea-coast which produces maritime species, or those that grow only within the influence of the sea-air, such as the live-oak and palmetto. The second extends inland as far as the long moss is produced; and the third extends to the middle district. A line drawn from Blakely on the Roanoke in the direction of Cheraw on the Pee Dee will very nearly mark the western bounds of the lower district, although the actual line is as irregular as the coast, and there is some overlapping of this with the adjoining district on the west. It embraces the pines, of which there are eight species, the most important

[1] The production is entirely from the wild shrub, no results of cultivation having yet appeared, although it is understood that some attempt has been made to introduce the Sicilian sumac. In 1870, over 1,900 tons, ground and crude, were shipped from Richmond, and the same year a mill at Winchester ground 800 tons, valued at $75,000.

[2] *The Woody Plants of North Carolina*, by Rev. M. A. Curtis, D. D., p. x.

being the long-leaf pine (*Pinus australis*), which is limited to this part of the State, and forms a prominent article of manufacture and a source for the production of turpentine.[1] It covers an area of nearly 15,000 square miles.[2] The yellow pine (*P. mitis*), is an important building timber throughout the State. The white pine (*P. strobus*), is limited to the spurs and plateaux of the mountain regions, where it grows in some places abundantly and of large size. The other species are less widely distributed, and less valuable, except the *Pinus taedia*, which in the eastern section grows to a large size, and furnishes an excellent timber.

The middle district reaches westward to the foot of the Blue Ridge, and is characterized by the predominance of oaks, of which there are about twenty species, of which the white oaks (*Quercus alba*, *Q. obtusiloba*, or "post oak," and *Q. prinus*), are most important and form extensive forests, and afford timber of great value. The vegetation of this district embraces many species found over a large part of the Southern and Middle States, and few that are peculiar to this part. The upper or mountain district ascends to the region of firs, and its flora partakes largely of the northern type. This region has from an early period been of interest to botanists, and has been explored by many eminent observers.[3]

The long-leaf pine forests were reduced about one-third throughout the whole region east of Raleigh to the coast, about thirty years ago, by a species of borer. They have not recovered. The chestnut was formerly abundant in the Piedmont region, down to the country between the Catawba and Yadkin Rivers, but within the last thirty years they have mostly perished. They are now found east of the Blue Ridge only on higher ridges and spurs of the mountains. They have suffered injury here, and are dying out, and both here and beyond the Blue Ridge. They are much less fruitful than they were a generation ago, and the crop is much more uncertain.—(*William C. Kerr*, State geologist, Raleigh, N. C.)

Rain-fall of North Carolina.

Prof. William C. Kerr, State geologist, has published the records of eighteen stations, embracing an aggregate of 62½ years' observations, which may be concisely stated by divisions, months, and seasons, as follows:

Rain-fall by months in inches.

Divisions.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Eastern	4.9	5.1	3.8	3.9	5.8	4.5	5.9	7.1	5.8	3.9	3.5	3.9
Middle	3.7	4.8	4.0	3.6	4.1	3.9	3.6	4.9	3.4	3.0	3.4	3.2
Western	5.4	8.3	5.5	5.3	3.7	5.3	5.5	6.4	2.8	1.7	3.1	5.2
State	4.5	5.3	4.0	3.9	4.9	4.3	4.9	6.1	4.5	3.3	3.4	3.7

Variation from mean of State.

Eastern	+ .4	− .2	− .2	+0.0	+ .9	+ .2	+1.0	+1.0	+1.3	+ .6	+ .1	+ .2
Middle	− .8	− .7	0.0	− .3	− .8	− .4	−1.3	−1.2	−1.1	− .3	0.0	− 1.5
Western	+ .9	+3.0	+1.5	+1.4	+1.2	+1.0	+0.6	+ .3	−1.7	−1.6	− .3	− 1.5

[1] A sketch of the extent of the pine region of this State is given on page 137 of this Report.

[2] *Appendix to the Report of the Geological Survey of North Carolina*, 1873, by William C. Kerr, p. 13.

[3] In the preface of his report Mr. Curtis mentions the various botanical explorations that have been made of this region.

Rain-fall by seasons.

Divisions.	Spring.	Summer.	Autumn.	Winter.	Year.
Eastern	13.5	17.5	13.2	13.9	58.1
Middle	11.7	12.4	9.8	11.7	45.6
Western	14.5	17.2	7.6	18.9	58.2
State	12.9	15.5	11.9	13.5	53.1

Variations from mean of State.

Eastern	+0.6	+2.0	+1.3	+0.4	+5.0
Middle	−1.2	−3.1	−2.1	−1.8	−7.5
Western	+1.6	+1.7	−4.3	+5.4	+5.1

The mountain region of the west appears to get a notable excess of rains except in autumn, when the deficiency is quite remarkable. The hilly or middle region receives least rain in every season, and in every month excepting May, while the flat country along the coast receives at every season and in every month, excepting February and March, a larger proportion than the average of the whole State.

At nearly all stations there was observed a marked predominance of westerly winds, inclining to the southwest in spring and summer and to the northwest in winter.

The following list of trees embraces all that are mentioned in the Report on the Woody Plants of North Carolina, by the Rev. Dr. Curtis, published as a part of the Geological and Natural History Survey of the State in 1860:

PINES.

1. Yellow Pine (*Pinus mitis*). Known also as "Short-leaved Pine" and "Spruce Pine." This is the most widely diffused of the pines, and is found from the coast to the mountains, but rarely in the lower district. Height, 40 to 60 feet; girth, 4 to 6 feet; heart-wood fine-grained but moderately resinous; the sap-wood perishable; used for house and ship building; grain coarser when grown in rich soil.
2. Jersey Pine (*P. inops*). Often confounded with the preceding and bearing same names, as also of "Cedar Pine," "River Pine," and "Scrub Pine"; found in the middle and upper districts, but not abundant. Height, 20 to 40 feet; diameter, 12 to 15 inches. Too small and often too crooked for use; often with much sap-wood.
3. Prickly Pine (*P. pungens*). Commonly not distinguished by common people from the Yellow Pine. Sometimes called "Table Mountain Pine," but found from Virginia to Georgia, and common on all the eastern spurs of the Blue Ridge, but never west. Height, 30 to 50 feet; diameter, 12 to 20 inches. Timber not deemed of special value.
4. Pitch Pine (*P. rigida*). Called sometimes in Virginia "Black Pine," and in North Carolina often confounded with yellow pine. Height, 30 to 50 feet. Timber generally very knotty, heavy, and resinous, but in low grounds lighter, with more sap-wood. It is used considerably, but is much inferior to yellow pine. This timber is nowhere very abundant.
5. Pond Pine (*P. serotina*). Common in small swamps and bays in the lower district, in company with Sweet Bay, Sour Gum, &c., and sometimes in the middle district. It covers large tracts on rich, swampy, and peaty land, but not in extensive forests; and in some places is called "Savanna Pine." Height, 40 to 50 feet; sometimes 80. Wood occasionally used for masts of small vessels.
6. Loblolly or Old-Field Pine (*P. tæda*). Next after the long-leaf pine, this is most abundant, coming up spontaneously in abandoned fields, and rising 50 to 70 feet, with a diameter of 2 to 3 feet, with a spreading top. Wood sappy and coarse-grained, liable to warp and shrink, and soon decays on exposure. It is the least valuable of the pines, but is used for some purposes, and is tapped for turpentine, yielding, however, less than the long-leaf Pine. An important variety, known as "Swamp Pine," "Slash Pine," and about Wilmington as "Rosemary Pine," sometimes grows in low moist lands to a large size. In the West Roanoke swamps it has been found 5 feet in diameter and 150 to 170 feet high.[1]

[1] A raft of stocks, cut in Bertie County, and passed through the Dismal Swamp Canal in May, 1856, for the Amsterdam market, consisted of 16 pieces, varying from 47 to

7. Long-Leaf Pine (*Pinus australis*). Often called the "Yellow Pine," and found from Southeastern Virginia southward to Florida, and westward across the Gulf States. Height, 60 to 70 feet; diameter, 15 to 20 inches. The wood contains but little sap, and the resinous matter is distributed very uniformly through it, rendering the timber durable, compact, and strong. In richer soil it is less resinous, and it is sometimes of a reddish hue, and hence is called "Red Pine," and is deemed better than other varieties. A tree with a small top is said to indicate the best heart-wood. It is the principal source of the turpentine of the Southern States. Tar is made by burning the dead limbs and wood in kilns. Large tracts of this pine are sometimes destroyed by insects which penetrate the bark and wood, and against which no remedy is known. The yellow pine (*P. mitis*) is subject to the same casualty.
8. White Pine (*P. strobus*). Grows on mountains, and not accessible to markets. Its timber is valuable, and has a local use. Found in this State 60 to 70 feet high and well proportioned.

FIRS AND SPRUCES.

1. Balsam Fir (*Abies Fraserii*). Much like the silver fir of Europe, but smaller, seldom reaching 40 feet, with a diameter of 12 to 15 inches. Occurs on the highest mountains, over 4,000 feet above the sea, where it sometimes forms forests. Its dark foliage gives name to Black Mountain. Scarcely available for timber, being generally inaccessible for market and too small for use.
2. Black Spruce (*A. nigra*). Common on mountains, and found at a lower level than the preceding. It is here a small tree, and of but little economical use.
3. White Spruce (*A. alba*). Rather rare in the mountains, being found in similar localities as the black spruce, and the wood serving the same uses.
4. Hemlock Spruce (*A. Canadensis*). Universally known in the mountain region as "Spruce Pine," and in the Northern States as "Hemlock." Found on the mountains, on the borders of torrents and cold swamps, but extending down to their base. Larger than the spruces, but much smaller than in northern localities.

White Cedar (*Cupressus thuyoides*). Confined to swamps in the lower district, where it is sometimes abundant, growing 70 to 80 feet high, with a diameter of 2 to 3 feet. This is one of the most valuable timber trees of the country, the wood being fine-grained, soft, light, and easily worked, with a strong aromatic odor. It is used for frames of buildings, shingles, and cooper wares, and its charcoal for gunpowder. Lampblack of best quality is made from this wood.

Cypress (*Taxodium distichum*). Deciduous, and abounding along the lower region of the Atlantic and Gulf States from Delaware to Texas, having in this State about the same range as the long-leaf pine, but always confined to swamps. Height, 60 to 100 feet; girths above the swollen base, often 20 to 30 feet. Wood strong, elastic, fine-grained, and lighter and less resinous than the pines. Very durable, and much used as frames, shingles, and fencing. There are three varieties of this species known in the trade—the *Red*, *Black*, and *White* Cypress, from the color of the heart-wood. The red is most valued; is less liable to split, and grows with a straight trunk, always swollen at the base. Top small, and the wounded bark reddish. The other varieties grow in similar localities, and are scarcely distinguishable until cut.

OAKS.

1. White Oak (*Quercus alba*). From the coast to the mountains, but most abundant in the middle district. In the lower it grows on the borders of swamps. In the most favored places it grows 70 to 80 feet high, with a diameter of 4 or 5, but it is usually not more than 2 feet through. Timber highly valued for frames, ship-building, carriage-work, agricultural implements, staves, &c.; in short, wherever strength and durability are required. Bark used in tanning.
2. Post Oak (*Q obtusiloba*). Enters largely into the composition of the forests of the middle district. Less common in the lower, where it is mostly confined to the swamps and lands that have gone out of cultivation. Rarely 50 feet high; diameter, 18 inches or less, but it has been seen 26 inches. Superior to white oak for fineness of grain, strength and elasticity, and highly valued as fence-posts, and for wagons, staves, and knees in ship-building.
3. Over-cup Oak (*Q. lyrata*). In the rich, swampy lands of the Neuse and Cape Fear and their tributaries, up as far as Chatham and Orange. Sometimes 80 feet high and 2 to 3 feet in diameter. Wood inferior to the preceding, but serviceable.
4. Swamp Chestnut Oak (*Q. prinus*). Met with in the rich soils of the river swamps in the lower district, 80 to 90 feet high, and well proportioned. Timber strong and

---

88 feet in length, squared on an average about 26 inches, the largest being 31, and averaged about 343 feet, the largest being 537. A piece previously cut in Bertie County was 80 feet long, 36 inches square at the lower end and 28 at the top, and was sold for $600. All these stocks were nearly all of heart-wood. The grain of this heart-wood is generally not very coarse, but more so than the long-leaf, and still more than the yellow pine.

durable, but more porous than white or post oak. It splits easily, and is used for baskets and brooms. Rails will last 12 to 15 years, and are valuable as fuel. Two varieties occur, the *discolor* and the *monticola*, by some botanists classed as species. The former, known as "Swamp White Oak," grows 70 to 80 feet high, with timber closely approaching the white oak in value, being strong, elastic, and heavier. The latter, known as "Rock Chestnut Oak," grows on high, rocky, or gravelly locations in the middle and upper districts; grows 50 to 60 feet high and 3 feet in diameter, but usually not more than 30 to 40 feet. Timber valuable, but pores open. As a fuel it is inferior only to hickory, and its bark is highly valued for tanning.

5. CHESTNUT OAK (*Q. castanea*). A single tree seen by Michaux on Cape Fear River, and possibly found in the western part of the State.
6. CHINQUAPIN OAK (*Q. prinoides*). Sometimes known as "Dwarf Chestnut Oak." A shrub 2 to 4 feet high and of no value. Occurs sparingly in the lower district and on poor soils elsewhere.
7. LIVE OAK (*Q. virens*). Along the coast; 40 to 50 feet high and 1 to 2 feet through. Most esteemed for ship-building and its bark for tanning.
8. WILLOW OAK (*Q. phellos*). On the borders of swamps in the lower district, where it grows 50 to 60 feet high and 2 feet in diameter; occasionally in the middle district. Wood very coarse-grained and inferior.
9. LAUREL OAK (*Q. laurifolia*). In the lower and middle districts, in similar localities as the preceding, but it grows well in higher and drier grounds, and is a common and much-admired shade-tree in towns, especially in the lower parts of the State.
10. SHINGLE OAK (*Q. imbricaria*). This takes the place of the preceding in the upper district, not being found east of Burke and Wilkes. From thence westward it becomes more abundant along the larger water-courses, especially those that flow west, as the Pigeon and Hiawassee. Grows 40 to 50 feet high and 12 to 15 inches in diameter, branches low, and casts a thick shade with its dark foliage. Wood hard and heavy, but porous.
11. UPLAND WILLOW OAK (*Q. cinerea*). Only in the pine barrens of the lower district where it is generally diffused. Rarely over 20 feet high and 6 inches in diameter Bark used in dyeing yellow. Too small and too scarce to be of importance. A dwarf variety, the *pumila*, rarely reaches 3 feet high, and bears acorns profusely at 15 to 20 inches. Found only in the lower district, especially near Wilmington.
12. WATER OAK (*Q. aquatica*). Abundant in the lower district, and in some parts of the middle, on the borders of swamps, and in river bottoms. It grows 40 to 50 feet high and 12 to 20 inches in diameter. Bark seldom used for tanning. Wood very tough, but not much used.
13. BLACK JACK (*Q. nigra*). A small and unsightly tree, from the coast to the mountains. Seldom over 30 feet high and 12 inches in diameter. Decays rapidly, and the wood is heavy and compact in large trees, but coarse and porous in small ones. Very valuable as a fuel.
14. SPANISH OAK (*Q. falcata*). One of the commonest of forest trees, from the coast to the mountains, but diminishes in quantity westward. Often over 80 feet high and 4 to 5 feet in diameter. Wood less durable and coarser than white oak, and bark highly valued for tanning.
15. BLACK OAK (*Q. tinctoria*). Most abundant in the upper part of the State. If in the lower district, it must occur sparingly. Wood reddish, coarse-grained, and porous, and bark highly valued for dyeing wool, calico, silk, and paper-hanging, furnishing the *quercitron* of commerce.
16. SCARLET OAK (*Q. coccinea*). Abounds chiefly in the middle and upper districts, not being generally diffused in the lower. Wood similar to the preceding, but not very durable nor useful. Both sometimes used for staves for holding dry articles.
17. RED OAK (*Q. rubra*). In the lower district found sparingly.
18. SCRUB OAK (*Q. Catesbaei*). Only found on the sandy barrens of the lower district, but may be found from the coast westward to Richmond and Moore Counties. Seldom 35 feet high, and usually 10 to 15. Bark used for tanning, but too scanty for value.
19. BEAR OAK (*Q. ilicifolia*). A shrub, 3 to 5 feet high. Very rare, and worthless, except as an indicator of barren soil.

HICKORIES.

1. SHELL-BARK HICKORY (*Carya alba*). Not abundant in any part of the State, and least of all in the lower district. Timber superior for all uses requiring elasticity and strength, but not durable when exposed to weather.
2. THICK SHELL-BARK HICKORY (*C. sulcata*). Not seen by Mr. Curtis in the State, but cited on authority of others.
3. COMMON HICKORY (*C. tomentosa*). Common in all the forests from the coast to the mountains, and the only hickory that occurs in the barrens. About 60 feet high, and 18 to 20 inches in diameter.
4. PIG-NUT HICKORY (*C. glabra*). Disseminated among other hickories.

5. Small-nut Hickory (*C. microcarpa*). Observed only in Caldwell County, although probably growing in the western counties.
6. Bitter-nut Hickory (*C. amara*). Not uncommon from the coast to the mountains. Prefers a rich cool soil, and grows 70 to 80 feet high, with a diameter of 2 feet or more; timber inferior to the other hickories.
7. Water Bitter-nut Hickory (*C. aquatica*). Found in swamps and river-bottoms, growing from 40 to 50 feet high; timber inferior to any of the preceding species of this genus.

WALNUTS.

1. Black Walnut (*Juglans nigra*). Found throughout the State, but not in the middle district, growing 40 to 50 feet high, and highly valued for cabinet-work. Husk used in dyeing, and the young fruit used for pickles and catsup. It is a pleasant shade-tree, and mingles well with other trees.
2. White Walnut; Butternut (*J. cinerea*). On bottom-lands and river-banks, in the valleys of the mountains; not east of Wilkes, but said to occur as far down as Orange and Randolph.

CHESTNUTS.

1. Chestnut (*Castanea vesca*). Chiefly on the mountains from Ashe to Cherokee, and but sparingly on the hills down to Guilford and Randolph Counties; usual height 50 to 70 feet, sometimes 90. Wood highly valued for rails and shingles, and sometimes used for staves for dry wares; valued as a fuel and for charcoal.
2. Chinquapin (*C. pumila*). From the coast to Cherokee, in great varieties of soil; usually 6 to 12 feet, but in cool and fertile places 30 to 40 feet high, and 12 to 18 inches in diameter. The dwarf variety *nana*, in poor soils, bears fruit at a foot in height.

BEECH.

(*Fagus ferruginea*). Sparingly in the lower district, and of small size; in the middle district, more common and luxuriant, but in the mountains abundant, and 50 to 80 or even 100 feet high, and 2 to 3 feet in diameter. Wood valuable for many uses, and durable if kept always dry or immersed. The bark contains some tanning properties.

BUCKEYES.

1. Yellow Buckeye (*Æsculus flava*). Most common on the sides of high mountains, and nowhere of larger size, growing 60 to 80 feet high and 3 to 4 feet in diameter, It indicates a deep, fertile, rich soil. In the middle district it is a shrub 3 to 6 feet high, along streams and in river-bottoms as far down as Orange County.
2. Red Buckeye (*Æ. pavia*). In the middle and lower districts usually 8 to 12 feet high, but sometimes a small tree. The root is sometimes used instead of soap for washing woolen cloths.

POD-BEARING TREES.

1. Locust (*Robinia pseudacacia*). Found native only on the lower ridges of the mountains in this State, but it was probably once found for some distance east of the Blue Ridge.
2. Clammy Locust (*R. viscosa*). Chiefly confined to the southern range of the mountains adjoining South Carolina and Georgia; seldom over 40 feet high.
3. Rose Locust (*R. hispida*). Indigenous to the rocky summit of mountains and hills in the middle and lower districts, and a dwarf variety in the pine barrens of the lower.

Honey Locust (*Gleditschia triacanthos*). Diffused over the State, but not abundant; growing 30 to 50 feet high, and from 2 to 3 feet in diameter.

Red Bud (*Cercis Canadensis*). Common in the middle and lower districts, especially the latter; growing from 15 to 25 feet high.

Catalpa (*Catalpa bignonioides*). Introduced, but common around settlements, not growing native in the Atlantic States north of Savannah River.

Kentucky Coffee Tree (*Gymnocladus Canadensis*). Occasionally cultivated in the middle district, and spreading from seeds.

MAPLES.

1. Red Maple (*Acer rubrum*). In swamps and low grounds, from the coast to the mountains; sometimes 70 feet high, and 3 to 4 feet through; wood solid, and used extensively in manufactures, but not durable if exposed to the weather; wood sometimes curly, and bark used for dyes; the sap somewhat saccharine, but seldom used for sugar.
2. White, or Silver Maple (*A. dasycarpum*). Much rarer than the preceding; sometimes 30 to 50 feet high, and 1 to 2 feet through; wood softer than other maples, and sap sometimes made into sugar of superior whiteness and flavor, but not more than half as productive as an equal quantity from the following.

3. Sugar Maple (*A. saccharinum*). Very abundant in the mountains, and found in the middle and lower districts; wood valuable, and sometimes highly ornamental; too remote from market to be of use for sugar, except locally; in the low country sugar cannot be made from it.
4. Striped Maple (*A. Pennsylvanium*). On the mountains only as a shrub, rarely over 10 feet high.
5. Mountain Maple (*A. spicatum*). Found only on the mountains as a shrub, 6 to 10 feet high.

Ash-Leaved Maple (*Negundo aceroides*). Generally known as the "box-elder" in the Western States; rare in the lower districts, but common on the borders of streams in the middle district to the mountains; usually growing 15 to 25 feet high.

ASHES.

1. Water Ash (*Fraxinus platycarpa*). Marshy borders of creeks and rivers in the lower district, where it is the only species of this genus; it grows 30 to 40 feet high, and timber less valuable than some other species of the ash.
2. Green Ash (*F. viridis*). Only in the middle and upper districts, on the banks of streams, as a middle-sized tree.
3. Red Ash (*F. pubescens*). Seen only in Lincoln County, but probably in rich swamps in the middle district.
4. White Ash (*F. Americana*). Not very abundant, but occurs on the borders of streams, in the middle and upper districts; it is sometimes 50 to 70 or 80 feet high, and 2 to 3 feet in diameter; its wood is regarded as the best of the ash tribe, and is highly valued for carriage-work, &c.

ELMS.

1. Elm (*Ulmus Americana*). Common, but not often over 60 to 70 feet high.
2. Small-leaved Elm (*U. alata*). Not uncommon, except on the higher mountains; growing 30 to 45 feet high; often planted as a shade-tree; wood compact and fine-grained, and is used for the naves of wheels.
3. Slippery or Red Elm (*U. fulva*). Occasionally in the lower district; more frequently in the middle, and to some extent in the upper. It grows 30 to 50 feet high, and 12 to 18 inches through; wood valued for ship-blocks, rails, &c.

STONE-FRUIT TREES, OR THOSE WITH SEEDS LIKE THE APPLE OR LIKE BERRIES.

1. Red Plum (*Prunus Americana*). From the coast to Cherokee, especially in the upper district; some good varieties have been cultivated from this stock.
2. Chickasaw Plum (*P. Chicasa*). Very common in old fields throughout the State; apparently introduced by Indians from the West.
3. Sloe (*P. spinosa*). In Lincoln County; perhaps naturalized.
4. Wild Black Cherry (*P. serotina*). Found throughout the State, but less common in the lower district; on slopes of mountains it grows 60 to 80 feet, with a diameter of 2 to 3 feet; formerly much used for cabinet wares, but now mostly superseded by mahogany and rosewood.
5. Wild Red Cherry (*P. Pennsylvanica*). Found sparingly on some of the higher mountains.
6. Mock Orange (*P. Caroliniana*). Confined to neighborhood of the ocean, not north of Cape Fear; chiefly valued in ornamental planting.

Devil Wood (*Olea Americana*). Of about the same range as the live-oak; worthy of cultivation.

1. Holly (*Ilex opaca*). Known throughout the State; from 30 to 40 feet high, and 12 to 15 inches in diameter; for avenues and hedges few trees are superior.
2. Dahoon Holly (*I. Dahoon*). A small tree 6 to 25 feet, on the borders of the pine barren ponds and swamps of the low country.
3. Yaupon (*I. Cassine*). Native place near salt water; 10 to 15 feet high, but sometimes 20 to 25; from this the famous "Black drink" of southern Indians was made for medicinal effect.
4. (*I. decidua*). In shady ravines throughout the middle district.
5. (*I. ambigua*). Deciduous; confined to mountains, and 8 to 20 feet high.
6. (*I. verticillata*). Deciduous; occurs throughout the State, from 2 to 10 feet high.
7. (*I. glabra*). In branch swamps of the lower district.
8. Gallberry, Tall Gallberry (*I. Coriacea*). Grows like the preceding.

1. Dogwood (*Cornus Florida*). Common throughout the State, grows 12 to 20 feet and sometimes 30 to 35.
2. Swamp Dogwood (*C. sericea*). In low woods in the middle and upper districts; the *C. paniculata*, *C. stricta*, and *C. alternifolia* also occur.

Hackberry (*Celtis occidentalis*). Found scatteringly in all parts of North Carolina.

1. Black Gum (*Nyssa aquatica*). Common in swamps and shallow ponds of the lower and middle districts; growing 30 to 45 feet high, and 12 to 18 inches in diameter. Wood extremely fibrous, so as to be very difficult to split.

2. (*N. multiflora*). In rich uplands in moist soils, 30 to 60 feet high, and 1 to 2 feet in diameter. Wood like the preceding species.
3. COTTON GUM (*N. Uniflora*). Limited to the deep swamps of the lower districts, growing 60 to 80 feet. Wood tough, but softer than the preceding, and, indeed, the softest wood in the State. Easily worked and made into light bowls and trays.

SASSAFRAS (*Sassafras officinale*). Common in the middle and lower districts, but rare in the higher parts of the upper, growing in favorable soils 40 to 50 feet in height.

RED BAY (*Persea Carolinensis*). Confined to branch swamps within the range of the long-leaved pine. A small tree, growing elsewhere 50 to 70 feet. Wood a beautiful rose-color, and sometimes made into veneers. Too small for use in this State.

1. PALMETTO (*Sabal palmetto*). Near the ocean south of Cape Hatteras. Trunks of this tree are valuable for wharves and in defensive military works. Rare in this State.
2. DWARF PALMETTO (*S. Adansonii*). In the lower district; 3 to 4 feet high.

PRIDE OF INDIA (*Melia azedarach*). Naturalized in the lower district as an ornamental tree.

BUCKTHORN (*Bumelia lycioides*). Sparingly from the coast to Lincoln County.

YELLOW WOOD (*Symplocos tinctoria*). From the coast to the mountains, but chiefly in the lower district; 20 to 25 feet high, and 6 to 8 inches in diameter. Leaves used in dyeing yellow with alum as a mordant. Wood soft and valueless.

MAGNOLIAS.

1. MAGNOLIA (*Magnolia grandiflora*). Northern limit in Brunswick County, but cultivated in all the lower part of the State. Height 50 to 70 and 90 feet. Timber soft, very white, and but little used.
2. SWEET BAY (*M. glauca*). Seen along branches and bays throughout the lower district, and more rarely in the middle; 12 to 25 and 30 feet high.
3. UMBRELLA TREE (*M. umbrella*). In deep, rich soils throughout the State, being often called "cucumber tree," a name more properly applied to the next species. Grows 25 to 35 feet high.
4. CUCUMBER TREE (*M. acuminata*). Only on the mountains, particularly of Ashe, Yancey, and Burke Counties, in moist, fertile soil of declivities, and on the banks of torrents. It grows 60 to 80 feet high, and 4 to 5 inches in diameter.
5. LARGE-LEAVED UMBRELLA TREE (*M. macrophylla*). Found only in Lincoln County, in this State, where it is met with in several places.
6. LONG-LEAVED CUCUMBER TREE (*M. Fraseri*). Only in mountain ravines in Ashe, Yancey, and Burke Counties, growing 40 to 45 feet in height, and 12 to 15 inches in diameter.
7. HEART-LEAVED CUCUMBER TREE (*M. cordata*). Declivities of mountains, Ashe County.

SERVICE BERRY (*Amelanchier Canadensis*). In the lower district, a shrub. On the sides of mountains it grows 15 to 25 feet high.

1. CRAB APPLE (*Pyrus coronaria*). Seen only on the mountains. Common in Yancey and Haywood Counties.
2. NARROW-LEAVED CRAB APPLE (*P. angustifolia*). Rather common in the lower and middle districts, and reaching into the upper.
3. CHOKE BERRY (*P. arbutifolia*). Borders of branches and bays in middle and lower districts.
4. MOUNTAIN ASH (*P. Americana*). Grows sparingly in the mountains.

PERSIMMON (*Diospyros Virginiana*). Throughout the State; growing 30 to 40 feet high, and sometimes 60, with a diameter of 18 to 20 inches.

MULBERRY (*Morus rubra*). In all parts of the State, but least abundant in the lower district; wood strong, solid, and durable, and mostly used for fencing and ship-building.

WHITE MULRERRY (*M. alba*). Introduced, as also the *M. nigra*.

RED CEDAR (*Juniperus Virginiana*). Grows 30 to 40 feet high and 10 to 12 inches in diameter, but smaller in the mountains than in the lower district; not abundant enough for use in the arts.

POPLARS.

1. CAROLINA POPLARS (*Populus angulata*). Rare in the middle district; more abundant in the low country, growing 60 to 80 feet high.
2. COTTON TREE (*P. heterophylla*). Rare in this State; found in rich swamp-lands on the lower course of the Cape Fear River.
3. LARGE-TOOTHED ASPEN (*P. grandidentata*). Upper part of the middle district.
4. LOMBARDY POPLAR (*P. dilatata*). Introduced.

BIRCHES.

1. RED BIRCH (*Betula nigra*). Common on the banks of rivers from the coast to the mountains, growing 40 to 60 feet high and 1 to 2 feet in diameter.

2. Black Birch (*B. lenta*). Found only on mountains.
3. Yellow Birch (*B. excelsa*). Near the highest summit of Black Mountain.

WILLOWS.

1. Black Willow (*Salix nigra*). This is the only native willow that becomes a tree. It is 15 to 25 feet high.
2. Gray Willow (*S. tristis*). In the mountains; a shrub 1 to 2 feet high.
3. Bush Willow (*S. humilis*). In middle and upper districts; rarely in the lower.
4. Silky-Leaved Willow (*S. sericea*). A shrub 3 to 6 feet high.

OTHER DRY-FRUITED TREES.

Hornbeam; Ironwood (*Carpinus Americana*). On the banks of streams throughout the State, growing 12 to 15 feet high, and sometimes 30. Wood hard, but too small for use.

Hop-Hornbeam (*Ostrya Virginica*). Very rare in the upper district.

Sycamore (*Platanus occidentalis*). Throughout the State, but least common in the lower district. Wood decays rapidly on exposure. Of rapid growth.

Sweet Gum (*Liquidambar styraciflua*). Common; growing 40 to 70 feet high, and 2 to 3 feet in diameter.

Tulip Tree, or Poplar (*Liriodendron tulipifera*). Native of all parts of the State, but not so common in the lower district. One tree was seen 9 feet in diameter; a more common size is 2 or 3 feet. It grows 60 to 100 feet high, and the timber much valued for building purposes. For rafters and joists it is the best substitute for pine, cedar, and cypress.

1. Basswood (*Tilia Americana*). On mountains and in the upper part of the middle district.
2. White Linn (*T. heterophylla*). More abundant in the upper district, but sparingly in the others.
3. Southern Linn (*T. pubescens*). Lower district; on the borders of swamps and rivers.

Sour Wood (*Oxydendrum arboreum*). Rare in the lower district; not uncommon in the middle, but most abundant in the lower parts of the mountains. Wood of no value. Leaves sometimes used in dyeing black.

Loblolly Bay (*Gordonia Lasianthus*). Within the range of the long-leaved pine, within 100 miles of the coast. Grows 50 to 70 feet, with a diameter of 18 to 24 inches. Wood of a rosy hue, silky luster and fine texture, but light, brittle, and subject to rapid decay unless kept dry. Bark might be used for tanning, if abundant.

Snowdrop Tree (*Halesia tetraptera*). Sparingly in the lower district, and found in the middle. Might be cultivated for ornament with advantage.

Planer Tree (*Planera aquatica*). From Cape Fear River southward on the borders of streams and swamps, growing 20 to 40 feet high, and 8 to 15 inches in diameter. Wood hard and strong, but too rare to be of importance.

The report of Mr. Curtis also contains the names of nearly 150 shrubs and nearly 30 vines, which are omitted as being unimportant in this connection.

Although North Carolina appears, from census statistics, to be abundantly supplied with timber—and the amount is really very considerable—its distribution is such that timber-planting offers an inviting subject for investment.

Prof. W. C. Kerr, the present State geologist, in his report of 1875 (p. 104), says:

> In some portions of the State already there is not timber enough to repair the annual decay of the fences; and yet the old habit continues of abandoning half-worn fields to sedge and sassafras, and pines and briers and gullies, and of clearing "new grounds," at a greater expense than would be necessary to restore the old, taking no account of the value of the forest destroyed in the process, which is almost always greater than that of the land after it is cleared; and this, while there is at least three times as much land cleared as can be properly tilled by the present agricultural force of the State. And the plan of fencing adopted when the whole country was forest-covered, and as one means of disposing of a considerable part of it, is still continued, long after not only this state of things has ceased to exist, but also the main purpose of fencing at all, which was to render available for cattle-grazing the rich natural pasturage which abounded in the "forest primeval," but has been long since extirpated, except in the higher and almost unpeopled regions of the mountains.
>
> And as the pasture-plants of our original forests have disappeared almost entirely from our flora, so under a similar reckless system of forest destruction * * * will

the most characteristic and valuable elements of our own unequaled forests disappear one by one. How this can come to pass is already but too evident to any one who has observed the woful destruction within a single generation of the long-leaf pine, for example, the most useful forest-tree of them all, or of the juniper or the palmetto, both on our own coasts, and especially of South Carolina.

In the swamps of North Carolina, bordering the sea-shore and tide-waters, there are successive generations of buried forests, the timber of which is in good preservation, and ready to be exhumed whenever there may be occasion.[1] The same is true, to some extent, in cedar and cypress swamps elsewhere.

Exportation, coastwise and foreign, of forest products from the port of Wilmington, N. C.

Commodities.	Coastwise.				Foreign.			
	1872.	1873.	1874.	1875.	1872.	1873.	1874.	1875.
Spirits of turpentine ....casks	59, 416	42, 283	42, 838	18, 559	77, 969	88, 953	83, 087	77, 882
Rosin..........bbls	423, 394	342, 499	309, 959	186, 938	196, 666	347, 652	379, 330	291, 812
Rosin-oil ......do.	....	....	133	156	....	....	....	....
Tar.............do.	32, 368	41, 030	47, 829	30, 540	4, 918	4, 296	20, 799	16, 619
Tar...........cases	....	....	717	770	....	....	....	....
Crude turpentine barrels...........	11, 558	14, 520	14, 945	7, 958	950	735	650	339
Pitch..........bbls	7, 072	8, 244	7, 316	3, 994	275	180	167	182
Lumber.......feet	16, 553, 746	12, 597, 597	9, 998, 295	3, 916, 066	6, 710, 436	6, 920, 171	4, 231, 030	5, 904, 541
Shingles	3, 323, 795	3, 960, 580	5, 432, 408	3, 330, 200	1, 534, 439	2, 378, 256	3, 087, 805	1, 859, 000
Juniper bolts ..No.	....	....	110, 476	76, 889	....	....	....	....
Shooks....bundles	....	....	4, 714	7, 430	....	....	....	....
Railroad-ties	....	....	....	....	....	....	22, 898	12, 113
Empty kegs, barrels, and hogsheads ...	....	....	3, 111	1, 350	....	....	150	511

Destination of forest products exported coastwise in 1875 from the port of Wilmington, N. C.

Commodities.	New York.	Baltimore.	Philadelphia.	Boston.	Bath.
Spirits of turpentine ....casks	8, 591	8, 298	1, 051	602	17
Rosin ....barrels	143, 029	27, 652	12, 037	4, 210	10
Rosin-oil ....do	1	155	....	....	....
Tar ....do	14, 745	7, 039	2, 230	6, 426	100
Tar ....cases	....	770	....	....	....
Crude turpentine.................barrels	7, 150	250	433	125	....
Pitch ....do	250	2, 085	1, 040	532	87
Lumber* ....feet	131, 023	1, 085, 138	792, 906	....	636, 154
Shingles..................................	1, 585, 250	....	1, 435, 350	309, 600	....
Juniper bolts........................ No	21, 787	....	55, 102	....	....
Shooks ....bundles	7, 426	4	....	....	....
Empty kegs, barrels, and hogsheads.....	62	434	854	....	....

*Also to Richmond, 350,811; to Thomaston, 343,065; to Bucksport, 181,320; to Providence, 255,000; and to Burlington, 141,650 feet. (From reports of the *Daily Journal;* Engineer's Report, 1876, part i. p. 310.

FLORIDA.

The water-shed of the Perdido and the Escambia, the Blackwater, and their affluents covers a large area of pine-lands. The Saint John River was also an important source of supply for several years before the late war, and is so still. A common estimate of yield of pine is 4,000 feet of lumber per acre, but good judges have expressed the opinion that this is too great for a general average. Cypress-lands will often cut 20,000. In this State, around the upper waters of the streams flowing into the Gulf, the principal government reservations of live-oak for the use of the Navy are located.

[1] *Geology of North Carolina* (Professor Kerr's report), i, p. 102.

Jacksonville is the principal port of shipment for the eastern part of Florida, and the amount of foreign export will be found in the statistical part of this report. We have no means at hand for showing the coastwise export.

Pensacola is a principal point of shipment for Western Florida, the lumber and timber being chiefly prepared at Perdido Bay, Escambia Bay, Blackwater River, and Chochowhatchie Bay. The amount of foreign exportation is given elsewhere from official statements. England and other European countries receive most of the timber, while New York, Boston, Philadelphia, Cuba, and South America afford a market for the lumber. In 1871 the total export from Pensacola amounted to 4,063,327 cubic feet of hewn timber and 1,057,455 feet of sawn lumber. In 1872 it amounted to 5,790,072 cubic feet of timber, and 45,753,574 feet of lumber. There were then 220 vessels employed in the trade, with an aggregate tonnage of 62,806. Besides this, several schooners were employed in the lumber-trade with New Orleans and Texas, that were not included in these totals. There were 34 saw-mills tributary to Pensacola.

During the year ending July 1, 1877, 270 foreign, 110 American, and 210 coasting vessels, having a total tonnage of 295,569 and an aggregate of 7,500 men as crews, arrived at the port of Pensacola. The value of exports was $2,291,822, mainly lumber and timber. On the line of the Pensacola Railroad are four saw-mills, with a cutting capacity of over 60,000,000 of feet annually. At Mill View, connected with Pensacola by the Pensacola and Perdido Railroad, are six mills, with a capacity of 65,000,000 of feet.

Large amounts of hewn and sawn timber are also floated down the tributary streams to the booms adjacent to the docks, where heavy timber is loaded into vessels, or on the cars by steam derricks[1].

GEORGIA.

By an agreement made April 24, 1802, between the State of Georgia and the United States, the lands west of a line described, were released to the general government, and those east of the line were confirmed to Georgia. The public lands of that State are therefore held under State laws, and about forty years ago were mostly disposed of by lottery, so that the principal part now belongs to private owners.

A Department of Agriculture has been for several years in operation, and forestry is, by the terms of the law made incidentally a subject of inquiry. It has, however, been chiefly matters pertaining strictly to agriculture. It has issued a Hand-book of general information and numerous circulars and special reports. We insert from the Hand-book a list of the woody species, so far as known. The vegetation of the State may be described in belts, each characterized by its peculiar flora. The seacoast belt has the palmetto, live-oak, American olive, magnolias, and other species common with the lowlands of the coast. Further inland is a broad belt of pines (*Pinus australis*, and other species), and in the mountains a flora not much differing from that of Western North Carolina already described.

---

[1]*Lumberman's Gazette*, March 9, 1878, p. 204.

Acres of original Woodlands in Farms and Plantations, as reported by the State Commissioner of Agriculture, and acres of Wild Lands as reported by the Controller-General, in 1875.

Counties.	Timber lands.		
	Original woods on farms.	Wild lands.	Total.
Appling	183, 663	210, 395	394, 058
Baker	60, 227	14, 126	74, 353
Baldwin	17, 717	90, 352	108, 069
Banks	47, 724	4, 737	52, 461
Bartow	103, 692	48, 783	152, 475
Berrien	....	7, 975	7, 975
Bibb	46, 903	905, 779	952, 682
Brooks	100, 529	81, 578	182, 107
Bryan	133, 279	31, 675	164, 954
Bullock	135, 552	50, 016	185, 568
Burke	1, 045	44, 855	45, 900
Butts	12, 833	5, 630	18, 463
Calhoun	....	11, 822	11, 822
Camden	....	141, 167	141, 167
Campbell	59, 739	9, 107	68, 846
Carroll	116, 029	15, 447	131, 476
Catoosa	52, 190	7, 205	59, 395
Charlton	3, 857	28, 671	32, 528
Chatham	7, 883	591, 040	598, 923
Chattahoochee	46, 876	4, 913	51, 789
Chattooga	80, 870	14, 148	95, 018
Cherokee	51, 661	6, 473	58, 134
Clarke	10, 439	91, 031	101, 470
Clay	54, 203	7, 526	61, 729
Clayton	19, 712	17, 567	37, 279
Clinch	3, 887	149, 056	152, 943
Cobb	58, 783	51, 227	110, 010
Coffee	120, 962	17, 814	138, 776
Columbia	21, 369	13, 041	34, 410
Colquitt	70, 369	53, 358	123, 727
Coweta	68, 746	40, 557	109, 303
Crawford	32, 040	8, 746	40, 786
Dade	25, 519	13, 674	39, 193
Dawson	62, 757	122, 308	185, 065
Decatur	143, 581	71, 690	215, 271
De Kalb	44, 674	13, 847	58, 521
Dodge	89, 737	376, 113	465, 850
Dooley	135, 819	79, 794	215, 613
Dougherty	25, 802	169, 612	195, 414
Douglas	....	19, 726	19, 726
Early	51, 513	17, 131	68, 644
Echols	66, 651	5, 000	71, 651
Effingham	95, 757	8, 393	104, 150
Elbert	34, 783	15, 455	50, 238
Emanuel	48, 191	83, 559	131, 750
Fannin	113, 310	7, 404	120, 714
Fayette	21, 200	3, 268	24, 468
Floyd	27, 532	41, 290	68, 822
Forsyth	43, 333	7, 259	50, 592
Franklin	115, 722	9, 002	124, 724
Fulton	42, 966	136, 635	179, 601
Gilmer	126, 986	5, 019	132, 005
Glascock	11, 945	5, 099	17, 044
Glynn	2, 529	106, 308	108, 837
Greene	87, 662	38, 011	125, 673
Gordon	20, 190	19, 011	39, 201
Gwinnett	82, 141	16, 406	98, 547
Habersham	....	17, 535	17, 535
Hall	....	19, 992	19, 992
Hancock	48, 489	15, 030	63, 519
Haralson	48, 466	27, 915	76, 381
Harris	59, 701	8, 894	68, 595
Hart	91, 018	6, 782	97, 800
Heard	74, 518	9, 511	84, 029
Henry	61, 417	12, 042	73, 459
Houston	33, 457	49, 650	83, 107
Irwin	....	124, 241	124, 241
Jackson	72, 376	17, 367	89, 743
Jasper	33, 310	9, 192	42, 502
Jefferson	....	20, 890	20, 890
Johnson	166, 784	18, 049	184, 833
Jones	14, 126	9, 657	23, 783
Laurens	84, 702	63, 199	147, 901
Lee	105, 163	10, 118	115, 281
Liberty	119, 163	13, 187	132, 350
Lincoln	21, 799	5, 658	27, 457
Lowndes	254, 200	94, 912	349, 112
Lumpkin	49, 209	5, 124	54, 333
Macon	....	11, 058	11, 058
Madison	54, 414	5, 273	59, 687
Marion	59, 468	13, 409	72, 877
McDuffie	20, 220	2, 815	23, 035
McIntosh	34, 685	120, 941	155, 626
Meriwether	82, 685	31, 377	114, 062
Miller	9, 722	3, 700	13, 422
Milton	29, 556	2, 457	32, 013
Mitchell	58, 524	16, 121	74, 645
Monroe	24, 828	21, 721	46, 549
Montgomery	....	24, 463	24, 463
Morgan	20, 173	34, 097	54, 270
Murray	629, 187	6, 511	635, 698
Muscogee	....	24, 474	24, 474
Newton	40, 281	26, 000	66, 281
Oconee	....	11, 531	11, 531
Oglethorpe	16, 300	30, 036	46, 336
Paulding	19, 977	24, 315	44, 292
Pickens	93, 003	5, 020	98, 023
Pierce	2, 202	43, 245	45, 447
Pike	50, 430	29, 092	79, 522
Polk	36, 463	34, 648	71, 111
Pulaski	101, 401	45, 155	146, 556
Putnam	24, 244	7, 971	32, 215
Quitman	20, 973	4, 984	25, 957
Rabun	141, 831	36, 900	178, 731
Randolph	95, 216	26, 277	121, 493
Richmond	47, 931	220, 218	268, 149
Rockdale	23, 451	6, 120	29, 571
Schley	22, 791	9, 116	31, 907
Screven	220, 100	25, 473	245, 573
Spalding	19, 643	96, 877	116, 520
Stewart	48, 111	12, 000	60, 111
Sumter	110, 152	34, 623	144, 775
Talbot	45, 022	147, 852	192, 874
Taliaferro	2, 925	11, 434	14, 359
Tatnall	....	27, 210	27, 210
Taylor	106, 047	35, 335	141, 382
Telfair	485	103, 746	104, 231
Terrell	39, 200	10, 935	50, 135
Thomas	192, 553	67, 643	260, 196
Towns	30, 419	2, 420	32, 839
Troup	59, 137	20, 002	79, 139
Twiggs	32, 572	25, 580	58, 152
Union	108, 253	1, 804	110, 057
Upson	56, 806	10, 658	67, 464
Walker	58, 831	26, 286	85, 117
Walton	20, 754	47, 564	68, 318
Ware	....	237, 605	237, 605
Warren	23, 330	8, 669	31, 999
Washington	85, 069	22, 235	107, 304
Wayne	....	32, 176	32, 176
Webster	30, 770	20, 503	51, 273
White	....	7, 835	7, 835
Whitfield	56, 008	23, 259	79, 267
Wilcox	46, 606	9, 849	56, 455
Wilkes	....	18, 778	18, 778
Wilkinson	30, 080	26, 958	57, 038
Worth	61, 632	58, 502	120, 134
Total	7, 825, 138	7, 068, 662	14,403,370

The Commissioner of Agriculture reported, for 1875, the area cultivated by various crops as 5,056,133 acres; pastures inclosed, 495,192 acres; acres inclosed by fences, 6,804,437.

The Controller-General reported for 1876:

Acres "improved"[1]	28,737,539,	valued at	$90,019,944
Acres of wild land	7,043,584,	valued at	1,835,828
Total	35,781,123,	valued at	91,855,772

MISSISSIPPI.

The southern part of this State is generally level, or but slightly undulating, and near the coast often marshy. The Mississippi River, below Vicksburg, is bordered by a bluff formation, which has a surface area about ten miles wide. This formation leaves the river at Vicksburg, and extends in a narrow belt northeastward and northward to the northwest corner of the State, leaving between it and the river an immense tract of bottom-lands, much of the way from 50 to 60 miles wide. East of the bluff formation, below Vicksburg, and occupying nearly a third of the State, occurs the grand Gulf group, or long leaf pine region.[2] This is generally undulating, frequently hilly, the surface-soil sandy, and the characteristic tree the *Pinus australis*. Around the edges this grows only on the higher ridges, but farther in it descends to the verge of the bottom-lands, but seldom actually grows on the flats. It is accompanied on the uplands by the black-jack, post-oak, &c., and on the hillsides by the black gum, dogwood, and other species. The frequency and size of these associated trees mark the variations in the fertility of the soil. Where the pine occurs alone the soil is generally very poor. The bottoms are generally quite narrow, with a light but productive soil, the timber being beech, magnolia, black gum, short leaf pine, &c. The timber growth generally is open, from the effect of fires, admitting of valuable pasturage.

Northward from this occur the yellow loam, central prairie, and northeastern prairie regions, which are more or less undulating or hilly, the prairies being generally small, irregular, and interspersed with woodlands. The northeastern prairie region[3] has underlying limestone formations of different geological ages. The timber varies considerably, according to soil and elevation, and includes the short-leaf pine, oaks of many species, sweet and black gums, poplar, dogwood, tupelo, willow, red cedar, chestnut, hickories, hackberry, hornbeam, ash, sycamore, mulberry, black walnut, redbud, pawpaw, &c.

Westward of this, in the northern part, lies the flatwoods region.[4] The level lands are timbered chiefly with post-oak; often with black-

[1] The term "improved" evidently applies to lands having a resident owner or occupant, and includes all the lands cultivated, as well as woodland, &c, belonging to such resident farms and plantations.

The area of the State of Georgia is generally estimated at 58,000 square miles, or 37,120,000 acres, which exceeds the above aggregate by 1,338,877 acres. It is probable that some lands are not included as taxable, which may account for this difference.

[2] This includes the eastern part of Wilkinson, Adams, Jefferson, and Claiborne Counties, the southern part of Hinds, Rankin, Smith, Jasper, and Wayne, and all south of these excepting a belt some ten or fifteen miles wide along the Gulf belonging to the coast-Pleiocene formation.

[3] Includes the whole or parts of the following counties, viz: Tishomingo, East Tippah, Itawamba, East Pontotoc, Monroe, East Choctaw, Lowndes, East Oktibbeha, East Noxubee, and Northeastern Kemper.

[4] Including parts of the counties of Tippah, Pontotoc, La Fayette, Chickasaw, Calhoun, Choctaw, Oktibbeha, Winston, Noxubee, and Kemper. The part popularly styled the "flatwoods" forms a narrow belt, bordering on the west, the Cretaceous formations of the northeast prairie region. Their usual width is three to six miles, but varies, and in places widens out to ten or twelve.

jack and short-leaf pine. The walnut, hickory, black, white, and true red oak and other species occur to more or less extent. The yellow loam region embraces a large area between the flatwoods and the Mississippi bottom-lands,[1] and is timbered with Spanish and red oaks, post-oaks of large size, hickory, black-jack, black or quercitron oak, short-leaf pine, sweet gum, &c.

The lower river counties where the bluff formation occurs, if underlaid by a stratum of brown, clayey loam, have a timber growth of white, chestnut, white, black, and Spanish oaks, beech, hickory, sweet and black gums, mixed more or less with holly, basswood, sassafras, elm, hornbeam, and magnolia. Where the soil is a light calcareous loam-silt, the timber consists of poplar, sweet gum, magnolia, mulberry, basswood, honey-locust, red haw, crab-apple, and sycamore. Sometimes the poplar, basswood, and sweet gum occupy the ground to the exclusion of all other kinds.[2]

Pascagoula has become a principal port for exportation of lumber in this State. The mills near this point are at the junction of the Pascagoula and Dog Rivers at Mossy Point, five miles from Pascagoula, Miss., which is adjacent to the Gulf shore, with numerous small bayous, inlets, and lakes, affording facilities for booming logs. In 1872, the business was divided among ten establishments, and the product amounted to 64,500,000 feet, with 1,500,000 of lath. In 1874, these mills employed three hundred and ninety-four men, ten gangs, and twelve circular-saws—had a daily capacity of 235,000 feet, and made during the year 46,000,000 feet.

The amount of lumber shipped from Pascagoula in 1876, in vessels cleared coastwise, was 6,908,339 feet; and for foreign ports, 13,679,571 feet. Shingles cleared coastwise, 1,179,250; and for foreign ports, 974,500. Timber for foreign ports, 885,346 feet. About 25 per cent. should be added to the coastwise trade for vessels not clearing at the custom-house. The square timber went to Europe and the West Indies; and the lumber to Europe, South America, Mexico, and the West Indies. Some of the vessels load directly alongside the mills; others outside the bar of Pascagoula River by lighters. The largest size timber ships lie in Ship Island Harbor near by.[3]

The State of Mississippi provided for the exhibition of some of its staple products at the Centennial Exhibition at Philadelphia in 1876, and erected a building intended to represent a rustic log-cabin in the Swiss style of architecture, the eaves being festooned with long, waving festoons of Spanish moss, and the whole presenting the most picturesque structure upon the premises. In the rough external part, and the panel work within, it contained 68 kinds of Mississippi woods, including 49 that were displayed on two panels on the wall of the front piazza. The building was 30 by 40 feet in size; and the specimens of timber were contributed by the Mississippi Valley Improvement Company.

TEXAS.

The public lands of Texas were reserved by the State for the payment of its public debt, at the time of its annexation to the United States in

[1] Comprising Northwest Tippah, Marshall, most of De Soto, East Panola, La Fayette, West Calhoun, Yaliabusha, part of East Tallahatchie, East Carroll, Choctaw, East Holmes, Northeast Yazoo, North Madison, Attala, Leake, Winston, Neshoba, part of Kemper, Lauderdale, most of Newton, and the northeast corner of Scott.

[2] The above generalizations are condensed from a *Report on the Geology and Agriculture of Mississippi*, by Eug. W. Hilgard (1860), to which the reader is referred for details.

[3] *Report of Mississippi State Board of Centennial Managers*, p. 34. The statistics above given were prepared by W. M. Gillespie, of Pascagoula, deputy collector for the district of Shieldsborough.

1845; and consequently no information is given concerning its land or timber in any reports of the general government. These lands are now in charge of the newly organized Department of Insurance, Statistics, and History; and in answer to inquiries for official information, the commissioner replies that, in the absence of specific information concerning the timber upon State lands, it may be said that the Eastern part of Texas is well timbered with valuable pine, and other growths; the middle and western portions are mostly prairie, with timber along the streams and on the hills, and in the Southern portions live-oak occurs. Trees where planted on the prairies in the vicinity of houses are growing rapidly.

TENNESSEE.

In the report on the "Resources of Tennessee," prepared by J. B. Killebrew and Prof. J. M. Safford, the following timber-trees are mentioned as having commercial importance in that State:

Ash (*Fraxinus Americana* and *F. viridis*). Formerly very plentiful in every part of the State, but now growing scarce except in places remote from facilities for transportation. It grows best in the coves and north sides of mountains, and in the rich lands of the Central Basin and West Tennessee. The largest trees are found in Bedford County, where it is abundant. It bears transplanting well and is eminently worthy of cultivation. As some pains are being taken to protect the young walnuts that are springing up in open woodlands in the Central Basin, it is hoped that the white ash, equally useful, will receive similar attention. The green ash (*F. viridis*) is met with only along water-courses. The timber is excellent, but not equal to the white. The water-ash (*F. platycarpa*) and red ash (*F. pubescens*) are not so abundant.

Beech (*Fagus feruaginea*). Common throughout the State in moist soils along streams. The largest groves are found in Mason, Trousdale, Smith, Sumner, Cannon, Bedford, and many other counties of the basin; used in manufactures and for fuel.

Birch (*Betula nigra*). Found along the streams in East Tennessee, especially on Clinch River. Rafts have been sent on that stream to Knoxville and Chattanooga and sold at good prices.

Buckeye (*Æsculus flava*). On rich soils in many parts of the State, more especially in the mountainous districts, where it is found 60 to 70 feet high and 3 feet in diameter; wood light, soft, porous, and not inclined to split; used for troughs, bread-trays, bowls, and shuttles.

Red Cedar (*Juniperus Virginiana*). Formerly very abundant in the Central Basin, in belts or strips, on the glady-limestone. The supplies in Davidson, Williamson, Sumner, and Rutherford nearly exhausted, and the best remaining are found in Marshall, Wilson, Bedford, and Maury, covering about 300 square miles. More than 700,000 feet are shipped annually to Saint Louis for fencing, and a large number of telegraph-poles go from Nashville. Bucket factories work up 5,000,000 feet annually. The reproduction is slow and trifling. The price of $9 a cord has been given for 5,000 cords for pavements in Pittsburg. Highly prized and much used as fencing, being extremely durable. A roof of red-cedar shingles has been known to last 80 years. In Marshall and Bedford Counties solid logs have been cut that would square 24 inches for 30 feet.

Chestnut (*Castanea vesca*). Abundant. Durable as rails, but not so durable for posts as locust or cedar. Large forests are found on the ridges of East Tennessee, on the sandstone soils of the Cumberland table-land, and in portions of the Highland Rim, especially in Lawrence, Wayne, Hickman, and Perry Counties.

Cherry (*Prunus serotina*). Loves a rich soil, and grows in every division of the State, often to 70 or 80 feet. No extensive groves are found anywhere, but the trees are usually scattered thinly through the forests on rich soils.

Cottonwood (*Populus heterophylla*). Confined to West Tennessee and the alluvial bottoms of the Mississippi, growing to a great size. Chiefly used for fuel.

Cypress (*Taxodium distichum*). In swamps along Mississippi and Tennessee Rivers in considerable abundance, in isolated forests and rarely with other trees Used for shingles and staves, and valuable for fencing and for hollow wares.

Dogwood (*Cornus florida.*) On rich soils in every part of the State, never growing to large size. Wood hard and valuable for many uses.

Elm (*Ulmus Americana*, *U. fulva*, and *U. alata*). The first of these grows to large size and is ornamental, but the timber not much used. The second (red or slippery elm) is smaller (40 to 60 feet high and 1 to 2 feet diameter) and not as common; wood coarser, stronger, and more durable. The third is still smaller, with tougher and heavier wood, and is more used for hubs of wheels.

FIRS. Of these, two species grow in the State, *Abies Fraserii*, the balsam fir, and *A. nigra*, the black fir or spruce. Some of the highest mountain peaks are covered with the balsams, and they seldom grow lower than 4,000 feet. Their dark hue gives name to the Black Mountains of North Carolina, and makes the characteristic feature of the Unakas. Being inaccessible it is rarely made into lumber, though growing often 100 feet high. It gathers balsam in blisters under the bark, which gives it the name. The black fir grows in similar localities.

GUM (*Nyssa aquatica*). The black gum or tupelo grows on rich, moist soils in West Tennessee, and to considerable size. Valuable for hubs, because its fibers are interwoven so that it cannot be split without difficulty. It makes good plank, but cannot be dressed smooth. The sweet gum (*Liquidamber styraciflua*) flourishes in wet, marshy places, and is largely used for plank for coarse use. It is cheaper than poplar and decays sooner. It exudes a gum highly prized by children for chewing.

HICKORY. Six species occur, viz: 1. *Carya alba*, shell-bark hickory. 2. *C. sulcata*, the thick shell-bark, more common in the mountains. 3. *C. tomentosa*, the common hickory. 4. *C. glabra*, the pignut hickory. 5. *C. microcarpa*, the small-nut hickory, and *C. amara*, the bitternut. The common hickory grows upon all soils of middling quality in the State, and is known by the great disproportion between the root when young and the root when grown, the latter being sometimes larger around than the tree, assuming a flat or grub-like form. It abounds in the "hickory barrens," on the Highland Rim. It rarely grows larger than 18 inches in diameter, when the timber is valuable for carriage-work. The shag-bark grows larger and splits more easily, and, like the *C. glabra*, seeks a fertile soil on river banks and hillsides. The wood of hickory is highly prized for fuel, burning rapidly with intense heat, and its ashes are very rich in potash.

LINN, LINDEN, or BASSWOOD (*Tilia Americana*). This is fond of a fertile soil, and is found with sugar-maple and walnut. It abounds in the blue-grass region of the Central Basin, and in some places in East Tennessee. The bark is sometimes used in making horse-collars.

BLACK OR YELLOW LOCUST (*Robina pseudacacia*), grows well upon almost any soil, and flourishes on the slopes of the Highlands and Cumberland Mountains, and on the sides of the Unakas. It is found on the north slopes of Clinch and Powell's Mountains, and will flourish in the glady places of the Central Basin where no other tree will survive. As a fence-post, it will last a century. It grows rapidly, and in ten years makes a post or railroad-tie. It rarely exceeds a foot in diameter, or thirty to forty feet in height.

HONEY LOCUST (*Gleditschia tricanthos*) abounds on all rich soils of the State, with walnut, elm, scale-bark hickory, hornbeam, ash, &c. Very valuable for posts.

MAPLE (*Acer saccharium*) abounds in the coves of the mountains and on the rich bottoms of the streams. *Acer rubrum* grows in wet soils and on margins of streams quite abundantly throughout the State, in localities suited for its growth. The *Acer dasycarpum*, or silver maple, is smaller and rarer. The wood of the first two of these maples is highly valuable for cabinet-work; that of the third is soft, very white, and fine-grained.

RED MULBERRY (*Morus rubra*), in rich soils, in every part of the State. Its wood is durable as fence-posts.

OAKS. Of the genus *Quercus*, the State has a dozen or more species. They grow in every county, more or less, and together form the great body of the timber. The white oak (*Q. alba*) is most valuable, growing to enormous size in the valley of the Tennessee, and in the first and second tiers of river counties in West Tennessee. It is also found in considerable quantities in many parts of East Tennessee, the best being on the ridges in the western part of that division, or in the tier of counties resting against the Cumberland table land, and on the slopes of the Unakas. The ridges and valleys along the Duck and Buffalo Rivers are covered with large white oaks, and this tree is generally scattered through the wooded regions of the Highland Rim. The wood is highly valued for wagons, plows, &c., and a large business has grown up on the Lower Tennessee in the manufacture of staves for the European market. From Hardin, Wayne, Perry, Humphreys, and Stewart Counties, the annual production is 1,635,000, about half being shipped out of the Cumberland. Heavy pipe-staves are 60 inches long, 5 wide, and 1½ thick; light pipe, 56 inches long, and of same width and thickness. Claret staves are 40 inches long.[1] Much oak is also used at Paducah, Memphis, and Mound City, for boat-building. Small oak is rived for hoops. It is highly valued for fence-rails. White oak generally sells standing at $1 a foot across the stump, and at the mills for $18 to $20

---

[1] The prices for making and price paid by foreign dealers in New Orleans, are as follows:

Heavy pipe, $1.40 to $2.25 per M for making; sold at $36 per M.
Light pipe, 80 cents to $1.10 per M for making; sold at $25 to $35 per M.
Claret staves, 80 cents to $1.00 per M for making; sold at $25 per M.

per M feet. The red oak (*Q. rubra*) grows everywhere in the State, and makes good roof-boards, staves for tobacco-hogsheads, flour-barrels, &c. It is more widely distributed than white oak, and is largely used in making charcoal. The post oak (*Q. obtusiloba*) prefers a dry, thin, gravelly soil, and is found in every part of the State. It is highly prized for railroad-ties and posts, and is more durable than the white oak. The chestnut oak (*Q. castanea*) delights in high, poor, barren, and rocky soil, in which it may be found in every part, especially on the leached soils of the Highland Rim. It is chiefly valued for its bark in tanning, and much bark is shipped to other States. Some trees on the Highland Rim and in East Tennessee will make a cord of bark, which sells, when ground, in Saint Louis, at $18. The black oak (*Q. tinctoria*) occurs in considerable quantities on the Highland Rim, especially in a rich loamy soil, as in Montgomery County and parts of Stewart and Robertson. This tree is deemed the most valuable for boards. It splits easily, does not curl up when nailed on a roof, and is largely used for staves of flour-barrels. It is a very valuable species, and forests of it sell very high. The scarlet oak (*Q. coccinea*) abounds in East Tennessee, and grows in moist places. It also occurs in small swampy spots in Middle and West Tennessee, but not in profitable quantities. The timber in quality and uses resembles the red oak. The black-jack oak (*Q. nigra*) is of not much account, though it covers a portion of the Barrens. It prefers a red clay, ferruginous, cherty soil, usually poor and thin, but sometimes fertile, as in the northern parts of Stewart and Montgomery Counties, which are very productive. These fertile lands, unlike the Barrens, have an undergrowth of gum, dogwood, and hazel, and of scrub hickory. This wood is least injured by the annual fires on the Barrens. It perishes in three years when made into rails, and is almost valueless except for fuel, and the abundant yield of potash. During the late war, much of it was converted into ashes for the manufacture of saltpeter. The remaining oaks of Tennessee have no economical importance, being limited in quantity, such as the swamp white oak, the overcup, the yellow oak, the small chestnut oak, laurel oak, Spanish oak, willow oak, bear oak, and perhaps other species. A specimen of nearly every tree mentioned may be found in the valley of East Tennessee, as the rich high ridges of that region give almost every condition of soil and climate.

PINES. These are among the most abundant and valuable of the forest growth. The two species of most value are the yellow or short-leaf (*Pinus mitis*) and white pine (*P. strobus*). The former grows in considerable quantities near Knoxville and on many of the parallel ridges of East Tennessee. It forms extensive forests on the Cumberland table-land and belts in Hardin and Lawrence Counties. Patches are found on the south sides of the hills in Wayne and less in several of the counties of the Highland Rim, and in West Tennessee. It abounds on poor soils, usually of sandstone, or on red clay with gravel. It takes possession of old fields and grows rapidly where the soil is too poor for other vegetatation. Its wood is used for lumber, being fine-grained, resinous, strong, and durable. The white pine is less abundant, but is found on the slopes of the Unaka Mountains and locally on the Cumberland table-lands. It grows to a larger size, and its wood is highly valued. The supply is limited, and much of it is inaccessible.

POPLAR (*Liriodendron tulipifera*). There are several varieties, known as blue, white, and yellow poplar, the latter being by far the most valuable. It grows on rich soil almost everywhere, the finest being seen in Obion and Dyer Counties, of West Tennessee, and Maury and Macon, in Middle Tennessee. This tree grows to a great size, and is found twenty to twenty-five feet in girth, and sixty to seventy feet to the limbs, and yielding 10,000 feet or more of good lumber. It is extensively made into lumber, and is more used in building than any other wood. Its greatest defect is the liability to shrink and swell in changes from dry to wet weather. It is not attacked by the borer. As rails, it will last fifty years. This lumber sells in market at $15 to $20 per 1,000 feet, and at the mills at $10 to $15. About 15,000,000 feet of logs of this timber are annually floated down the Cumberland in rafts to Nashville.

SASSAFRAS (*Sassafras officinale*). Common as a shrub in every part of the State, especially in the valley of Middle Tennessee and on the Highland Rim. In West Tennessee it becomes a stately tree. One specimen measured 60 inches across inside of the bark. The wood is soft, brittle, rigid, close-grained, and is used for studding, and to some extent for furniture. The sprouts of this tree are extremely troublesome in fields. The roots have been used as a tea. The pith is scraped out with an awl-shaped instrument, and is valuable for mucilage, being worth when dry $3 to $4 a pound.

SYCAMORE (*Platanus occidentalis*). Grows along the margins of streams in every part of the State. Its wood is used in making furniture. The timber does not split easily, and decays very soon in the weather. It is troublesome on account of sprouts that it sends up from the stump.

WALNUT.—The black walnut (*Juglans nigra*) is pretty generally distributed over the rich soils of the State, and it is a sign of fertility. It abounds in the great Central Basin and the better part of the Highlands, and flourishes on the north sides of ridges and in the valleys of East Tennessee. It attains a marvelous size on the calcareo-silicious soils of West Tennessee. A grove on the Cumberland table-land, a few miles from Wartburg, in the eastern part of Morgan County, could scarcely be surpassed ; some trees being 6 feet in diameter and more than 100 feet high and thickly set. The bark of the black walnut is used as a domestic dye for woolen. The butternut, or white walnut (*Juglans cinerea*) prefers the margins of streams and rich northern slopes, and is generally diffused. Its wood makes a lumber valued for inside finishing and for cabinet wares.

Of trees not sufficiently abundant to be of much economical importance may be mentioned the yellowwood, cucumber, laurel, holly, hornbeam, box elder, chinquapin, crab apple, hackberry, willow, persimmon, &c.

The report from which the above statements are condensed, remarks—

That though the State of Tennessee has as yet an abundant supply of timber, it is every year becoming more apparent that some legislation is demanded for its preservation and reproduction. In the neighborhood of our furnaces, especially, the consumption of timber is enormous, and many of our finest iron fields will soon be deprived of half their value unless some legislative protection is given to the young timber. The annual conflagrations that sweep like a devouring fury through the old coaling lands, destroying the young sprouts and rendering barren a large scope of country, should be checked. But for these fires, the timber would soon reproduce itself in sufficient quantities to supply all the demands of the charcoal furnaces. Old fields are lying idle and unfenced in every part of the State, that could be reclaimed by being planted in trees. Were these places broken up and sown with acorns or hickory nuts, or planted with locust trees, the effect would, in every particular, be salutary. Not only would the land be reclaimed, but the timber would in two score years be valuable. * * * The legislature should exempt from taxation for a term of years all these old fields that are planted with trees, and $100 worth of property should also be exempted for every mile of shade trees planted along the highways. * * * Had this been done twenty years ago, Tennessee would not be dotted all over with repulsive and haggard old fields that constitute the shame and mark the shiftlessness of her farmers. * * * More is involved in this question than mere money. The very existence of the human race is jeopardized by this neglect.

KENTUCKY.

Prof. N. S. Shaler, in charge of the Geological Survey of Kentucky, in speaking of the future prospects of the timber of that State, remarks:[1]

I am satisfied that by properly husbanding our timber resources, they will in fifty years become one of the most important of the varied sources of wealth to our State. A large part of the eastern coal-field of Kentucky is not tillable land. The lofty and rugged ridges between the valleys are natural nurseries of timber. While they will not serve for other forms of cultivation, they will yet do admirably for the raising of many of the most valuable woods for our various arts. So large a part of the valley of the Ohio is arable land, that the future sources of timber for its use are very limited. They will be found in the lofty ridges of the Apalachian Mountains where the steepness of the slopes will forbid plow-tillage.

I deem it quite likely that within the time of the next generation, these hill lands will become as valuable for timber raising, as the average lands of the valley are for other forms of culture. They are naturally suited to all the most valuable woods of the Mississippi Valley. At the present value of black walnut, an acre of this timber forty years old, growing as thickly as it is able to stand, should be worth several hundred dollars; of hickory and locust of second growth, the value is about as great. There are few crops of ordinary soil which will give as great average returns when labor and interest are deducted. A very great advantage in our Kentucky forests is the comparative immunity from fires. In most valuable timber regions this danger is so great as to reduce the value of such lands as investments. In many thousand miles of travel through the timbered districts of Kentucky, I have never seen an acre of forest seriously damaged by fire. In the present state of our American life, when men are hardly willing to wait for the yearly harvests to mature, it seems almost too much to hope for the far-seeing thrift that will look forward to fruits to be gathered at the end of forty years; yet these enterprises that take hold on a distant future will become

[1] *Geological Report of Kentucky*, part I, vol. 1, 2d series, p. 4.

more attractive, with a growth of capital, and an increase of confidence in life. But in fact a large part of the value of such growths as our forests would give when artificially planted would be immediate. At five years young hickories have a value, and the trees removed by trimming out each year should pay an interest on investment. A black locust becomes valuable in ten years, or nearly as soon as a pear-orchard, and for thirty years thereafter should give a steady supply of timber. With each succeeding year these woods become more and more valuable, as the original forests become stripped of their scanty supply. The best black walnut is already priced with mahogany in Europe, bringing several dollars per cubic foot. The abundant water-ways of the Ohio Valley will always make its regions of permanent forest of peculiar value.

Prof. L. H. De Friese, an assistant in the geological survey of Kentucky, in speaking of the connection between geology and botany, remarks an example in Grayson County. The Coal-Measure series crosses the Litchfield and Hartford road in a very irregular northwest and southeast direction about 12 miles from Litchfield. North of this, on through the Coal Measures to the Ohio, the *Liriodendron tulipifera* (there called "yellow poplar") forms a conspicuous part of the forest, its massive cylindrical trunk growing from two to five feet in diameter. It is seen everywhere, on low lands and high lands alike. But after crossing into the Chester shale it disappears entirely, only a few scrubby trees being found near the junction. After crossing this shale this tree reappears on the Saint Louis limestone of the Sub-carboniferous series.

He notices another change of timber due to a modification of the surface soil in a remarkable belt of woods crossing the Hartford and Cloverport road about 12 miles from Cloverport. It is about five miles wide, on a soil of thin, shaly limestone, forming a nearly level tract of land. Although, at least 150 feet above the drainage, the soil is always moist, and the liriodendron, chestnut, white-oak, and three varieties of hickory, grow with a luxuriance that is scarcely surpassed anywhere in the State. There is also found in this belt of exceptionally heavy timber growth, but in less numbers, the laurel-oak, black sugar-maple, water-beech water elm, etc. The change is very marked in passing on either side out of this belt into the ordinary timbers.[1]

The black walnut is found scattered all through Western Kentucky, in open places and about fields, where other timbers had been cut away or deadened. It is all nearly second growth, however, the old forest growth having been ruthlessly destroyed. The largest amount of primal walnut timber I found was on Beech Fork, or Clover Creek, up near the headwaters; occasionally a forest tree of it is left standing in other localities, but it is very rare. Even the second growth, which would be valuable in time, is meeting with the same fate as the first, and reckless hands are cutting it away for such rude purposes as rail-making as fast as it springs up. From the study I made of the walnut, I find the second growth comes up only in open spots of ground where it is not overshadowed and choked out by other more rapidly growing and less valuable timbers. That causes it to spring up mostly about dwelling-houses and cleared pieces of ground, the very localities where it soonest meets with destruction. If farmers could only consider that a single tree of good walnut timber is worth more than their best acre of land, they would take more pains to encourage the growth of a timber which is becoming so scarce in our country, and for which there is such great demand. I believe, with a little extra care, such as trimming out and killing other fast-growing timbers of little or no value, taking moderate pains to secure, in such localities as best suited the walnut, a good undergrowth of it, etc., that a considerable forest of this valuable timber might be secured and kept in Kentucky.

[1] *Report on the timbers of Grayson, Breckenridge, Ohio, and Hancock Counties*, p. 6.

Next to the walnut in value, and fully as scarce, is the black cherry. The wood is so valuable in cabinet work, for the reason that it is very compact, close grained, and receives a high polish. In a few years, at the present rate of destruction, it will have disappeared from our Kentucky forests.[1]

In an examination of the timbers of Grayson, Breckenridge, Ohio, and Hancock Counties, in connection with the geological survey of Kentucky[2], Mr. De Friese, an assistant on the survey, remarked, that the younger growth destined to form the future forests of the country, often differed in relative abundance and in species from the original growth. In speaking of the white oak he observes:

> I took particular pains to notice the conditions of growth of the white oak, and I find that, while at present it forms the large per cent. of the forest timbers, in the undergrowth it falls from 40 or 50 per cent. to about 8, while its place is being taken by such valueless timbers as the pin-oak, black oak, Spanish oak, and black hickory. This proves that the latter are of more rapid and hardy growth, and that in the contest for supremacy, the white oak will finally be exterminated. The extinction of our white oak would be nothing less than a calamity—one which should be avoided if possible.

As an indication of the tendency to change, as shown in the forests of Western Kentucky, the following tables are given in the report above cited:

Old forest growth.	Per cent.
White oak	40
Liriodendron	10
Black gum	9
Hickory	8½
Sugar-tree	8½
Post oak	7
Black oak	7
Spanish oak	2½
Chestnut	2
Dogwood	2
Sycamore	1
White ash	1
Red oak	½
Pin-oak	½
Maple	½

Young forest growth.	Per cent.
Black oak	36
Pin-oak	36
Black walnut	19
White oak	9.4
Hickory	6.6
Black gum	5.2
Post oak	[illegible]
Liriodendron	2.36
Sycamore	1

The tendency to deterioration shown by the above comparison, indicates the importance of giving timely attention to the young growth in woodlands, by giving it encouragement by the suppression of the less valuable species.

In a report upon the timber growth of Greenup, Carter, Boyd, and Lawrence Counties, Kentucky, made by A. R. Crandall, in connection with the geological report of that State,[3] a count was made of the number of old forest trees of twenty species, at eight separate stations, and of second growth trees at seven stations, with the view of determining the relative frequency of species in the two conditions. The second growth had been cut off some years before for supplying charcoal to iron-furnaces. In some instances a third growth was examined, but there appeared no material difference when compared with the second. In the following table, we present the general result as observed of valley, hill-side, and hill-top, and the combined result of all, and have

[1] L. H. De Friese, *in report on timbers of Grayson, Breckenridge, Ohio, and Hancock Counties.*—Geological Survey of Kentucky, part ix, vol. ii, 2d series, p. 8.
[2] *Geological Survey of Kentucky*, part ix, vol. ii, 2d series, p. 14, 15.
[3] *Geological Survey of Kentucky*, part I, vol. I, 2d series.

added columns for showing the order of frequency of the several species, the more numerous being marked 1, the next 2, and so on to the end. But in doing this, there occasionally occurs the same proportion in two or more species, and in this case we have assigned the same numeral order to each, designating by a star the duplicate or other number of species that belong to this numerical order.

Percentage and relative order of frequency of timber-trees in Eastern Kentucky.

Species.	Old forest (eight stations).								Second growth (seven stations).					
	Percentage of trees.				Number in order of frequency.				Percentage of trees.			Number in order of frequency.		
	Valley.	Hill-side.	Hill-top.	All localities.	Valley.	Hill-side.	Hill-top.	All localities.	Hill-side.	Hill-top.	All localities.	Hill-side.	Hill-top.	All localities.
White oak	.149	.237	.129	.171	2	1	3	1	.191	.210	.202	1	1	1
Black oak	.061	.129	.164	.117	5	2	2	3	.189	.191	.190	2	2	2
Chestnut-oak	......	.044	.297	.112	....	8	1	4	.050	.045	.048	8	7	6
Post-oak	......	......	.018	.007	...	....	10	16*	.019	.015	.017	12	11	13
Other oaks	.017	.046	.055	.038	10	7*	6	9	.138	.141	.140	3	3	3
Beech	.278	.069	......	.119	1	4	....	2	.065	.014	.039	6	12	9
Maple	.116	.046	.005	.057	3	7*	11	6	.030	.024	.027	10	10*	11
Chestnut	.020	.032	.053	.035	10	8	7	10	.069	.071	.070	5	5	5
Hickory	.030	.120	.100	.082	8	3	5	5	.080	.098	.089	4	4	4
Yellow poplar	.064	.058	.035	.052	3	6	8	8	.054	.031	.042	7	9	8
Gum	.031	.046	.026	.034	7	7*	9	11	.015	.024	.019	13	10*	12
Ash	.007	.018	.006	.010	11*	11	12	10	.011	.024	.016	14	10*	14*
Linden	.026	.015	......	.014	8*	12	....	15	......	......	.003	...	...	16
Sycamore	.062	......	......	.022	4	....	...	12	......	......	......	...	...	...
Buckeye	.021	......	......	.007	9	...	....	16*	......	......	......	...	...	...
Elm	.037	.021	......	.020	6	10	...	13	.010	......	.005	15	....	15
Black walnut	.026	.023	.003	.017	8*	9	13	14	.049	.043	.046	9	8	7
White walnut	.007	......	.002	.003	11*	....	14	17*	.022	.010	.016	11	13	14*
Hemlock	.047	.009	......	.003	5	13	...	17*	......	......	......	...	...	...
Pine	......	.067	.106	.056	....	5	4	7	.007	.056	.031	16	6	10

* More than one having this number.

The "barrens" of Kentucky and Tennessee.

Extensive tracts of irregular form occurred in these States, when first explored, which were quite destitute of timber, or the remains of forests in the way of fallen trunks or stumps, excepting here and there a knoll of timber, on gravelly soil. They were in fact *prairies*, and apparently caused by the annual burning of the herbage, as practiced by the Indians, either to drive game, to encourage the growth of fresh grass for deer, or perhaps to destroy the lurking-places of enemies, or to prevent accidents from unexpected fires. These lands have proved highly productive under cultivation, and since the fires have been prevented, they have grown up in timber, but not so varied in kind as that found in adjacent native forests, nor as a general thing so valuable for use. This rapid restoration of forests in these States, and in parts of Ohio and Indiana, while the process is slow in Illinois, has been thought to be due to a more recent origin, and the endurance of living seeds in the soil.[1] It has been observed that the area of these old barrens is somewhat limited to the surface area of the conglomerates underlying the coal formation of these States.[2] This subject is being studied in connection with the geological survey of Kentucky, and the details are

[1] *Prof. N. S. Shaler*, Geological Survey of Kentucky, part II, vol. I, 2d ser., p. 4.
[2] *Mr. John R. Proctor*, Assistant of Kentucky Survey.

promised in a series of memoirs that is in course of publication on the distribution of the Forest Trees of Kentucky.[1]

In relation to the varieties of spontaneous growth found on the Barrens of Kentucky, it is observed that the oaks are mostly of the following species: *Quercus coccinea*, *rubra*, and *nigra*, the latter being most common. The *Q. alba* is found, but not abundantly, and about the sink-holes the *Q. imbricata* and *Q. obtusiloba* are found. There are no tulip-poplars, basswoods, beeches, black walnuts, or butternuts, and but very few willows or maples. The largest oaks are about 15 inches in diameter at three feet from the ground.

A local law, applicable to the counties of Trimble and Oldham, and the part of Carroll below the mouth of the Kentucky River, was passed March 11, 1876, which was designed to prevent the range of stock along the banks of the Ohio River. The preamble recites the damage being done in these places by the undermining of banks, and the attempts of owners, in planting willows and other shrubs and trees of rapid growth, to prevent erosion, and allows stock running at large to be taken up and the owners to be fined from $5 to $15 for each offense.

The recently-established State Bureau of Agriculture, Horticulture, and Statistics, will doubtless include inquiries relating to forest resources, in its programme of operation.

WEST VIRGINIA.

The *West Virginia Handbook*[2] (p. 104) presents the following list of timber-trees in this State, with some notes concerning their distribution, size, and uses:

WHITE PINE (*Pinus strobus*). Seldom over 120 feet high, and not very prevalent; timber equal to Pennsylvania or Michigan pine.

PITCH PINE (*P. rigida*). Never over 60 feet high; thin sandy ridges; not very abundant, but rich in turpentine.[3]

YELLOW PINE (*P. mitis*). From 50 to 85 feet high; tops of ridges, solitary or in small clusters; timber valuable—not subject to warp or twist; found in considerable quantities in Raleigh, Wayne, Logan, and Lincoln Counties.

HEMLOCK (*Abies Canadensis*). Rich mountain and table lands; 70 to 100 feet high.

BLACK SPRUCE (*A. nigra*). Banks of streams and other damp places; a handsome tree, 50 to 60 feet high; of pyramidal form in open grounds; wood not used.

RED CEDAR (*Juniperus Virginiana*). Moderate-sized tree, of pyramidal shape; thinly scattered through the State; disposed to come up as second growth on thin land; wood light and very durable.

HOLLY (*Ilex opaca*). Mountain streams, and on gravelly and stony soil; grows 15 feet high; wood tough, and good for turning.

LAUREL (*Kalmia latifolia*). Thin cold hill-sides and mountains; from 4 to 10 feet high. Two varieties are noticed, the largest on Tygart's Valley River and other streams of similar elevation; leaves poisonous for cattle.

WHITE OAK (*Quercus alba*). Large and abundant on river-bottoms, on hill-sides, and ridges; growing 75 to 100 feet high, and 2½ to 4 feet in diameter; grows in dense woods without limbs to two-thirds of its height; bears acorns on an average once in two years.

---

[1] The memoirs already published are:

"*Report on the Forests of Greenup, Carter, Boyd, and Lawrence Counties*," by N. S. Shaler and A. R. Crandall, part I, vol. I, 2d series, pp. 34.

"*Report on the Botany of Barren and Edmonston Counties*," by John Hussey, with an introduction by N. S. Shaler, part II, vol. I, 2d series, pp. 32.

"*Report on the Timbers of Grayson, Breckinridge, Ohio, and Hancock Counties*," by L. H. De Friese, part IX, vol. II, 2d series, pp. 20.

[2] Prepared by J. H. DissDebar, Commissioner of Immigration for the State of West Virginia.

[3] Estimates made in a lumber interest, represent the white pine along the Greenbrier River on its upper waters, as making 4 to 7 cuts of 16 feet to a tree, and averaging 5 cuts to the 1,000 feet, and sometimes 40,000 feet to the acre. It grows at an altitude of 2,000 to 2,500 feet. Estimates place the amount in several timber districts at 300,000,000 feet.

RED OAK (*Q. rubra*). Not as large as white oak, nor so straight and durable; bark rough and dark; used for tanning; wood coarse and heavy; acorns large, but inferior for mast.

BLACK OAK (*Q. tinctoria*). From 40 to 80 feet high; bark valuable for tanning and dyeing; and wood forming good timber. It occurs on high benches and ridges.

JACK OAK (*Q. nigra*). Scrubby; not over 30 to 40 feet high on thin, sandy ridges; not valuable.

CHESTNUT OAK (*Q. castanea*). Abundant on rather thin and stony or clayey ridges and benches, but very thrifty in good soil; grows 60 to 80 feet; wood tough and durable—equal to white oak for many uses; furnishes a larger supply of tan-bark than any other oak.

SPANISH OAK (*Q. falcata*). Not abundant; 60 to 80 feet high; tough and valuable wood for staves, and bark used for tanning. There are also some other oaks growing in the State, some of them of large size, and others shrubs.

TULIP POPLAR (*Liriodendron tulipifera*). The white and yellow poplar—the latter most valuable for flooring, ceiling, and cabinet-work, and for shingles, answering for pine. It is the largest tree of West Virginia, growing 100 to 150 feet, with corresponding diameter.[1] It grows equally well in the valleys, and on rich hill-sides and ridges. Paper has been made from the bark.

BLACK WALNUT (*Juglans nigra*). Grows 50 to 80 feet high, and 3 to 6 in diameter; found in rich soil, at any elevation, but nowhere so abundant as in some mountain sections.

WHITE WALNUT, (*J. cinerea*). Nearly as large as the black, and multiplies more rapidly.

HICKORY (*Carya sulcata; C. alba*). These abound in rich soil among the deciduous timber; height, 80 to 100 feet; seldom over 2½ to 3 feet thick; grain fine, hard, and flexible, and full the best in the woods.

WHITE-HEART HICKORY, (*C. tomentosa*). Similar in wood to the above, but white at the heart; bark rough, not scaly.

BROOM HICKORY (*C. porcina*). Resembles the above; fiber very tough; best for brooms.

CHESTNUT (*Castanea vesca*). Large and spreading tree; on dry, elevated ground, in every part of the State, but more abundant on the mountains. It grows rapidly, and reproduces from sprout or seed once in 15 or 20 years, to a size for posts and rails.

CHINQUAPIN (*C. pumila*). Small tree; not abundant.

BUCKEYE (*Æsculus glabra*). Large tree, of rapid growth; prefers bottom-lands; soft; not durable if exposed; bears fruit early; not edible.

LOCUST, (*Robinia pseudacacia*). Good-sized tree, in thin or open woods on high ground; irregularly distributed, generally in groves; a rapid grower, and easily propagated.

HONEY LOCUST (*Gleditschia tricanthos*). Moderate-sized tree; not abundant.

BEECH (*Fagus ferruginea*). Red and white; found in bottoms and on lower benches, all over the State; moderately abundant; height 50 to 60 feet; not much used except for fuel; good for boxes, journals in machinery, chair-bottoms, and fence, boards, when nailed up and exposed to the air immediately after being sawed.

SYCAMORE (*Platanus occidentalis*). A very large picturesque tree, 70 to 120 feet high' solitary or in clusters along the banks of rivers; wood fine and hard; used for bedsteads and other turned furniture; grows rapidly and easily propagated.

ELM (*Ulmus Americana*). A very handsome spreading tree, 60 to 80 feet high; seldom found in the woods, but usual on the banks of streams, and in more or less open grounds; seldom cut down for any purpose.

CUCUMBER (*Magnolia acuminata*). Moderate-sized tree, seldom over 70 feet high; wood white, not very hard or fibrous; good for turning and hollow ware; bark medicinal.

LINDEN (*Tilia Americana*). Rich soil; 60 to 80 feet; wood soft, white, and adapted to light cabinet-work and paper-making.

WHITE ASH (*Fraxinus Americana*). Large, straight tree, on rich hill-sides; wood tough and elastic; used for flooring, mill-work, and carriages.

MOUNTAIN ASH (*Pyrus Americana*). Not over 40 feet high; said to occur on the mountains.

---

[1] Several trees are reported 10 and 11 feet in diameter. The nature of the soil on which this timber grows has a striking effect on the color and quality of the wood. Mechanics distinguish the white, blue, and yellow, but no external marks distinguish them. The white variety generally prefers a dry, elevated, gravelly ground; has a branching head, with a small amount of heart-wood, has a coarser and harder grain, and decays more rapidly. The blue has the same general character. The yellow poplar, by far the finest, is extensively used as an inside finishing lumber, for shingles, and as weather-boarding. It affords a good foundation for veneers, and is used in cabinet-wares, &c.—(*Resources of West Virginia*, p. 133.)

WILD CHERRY (*Cerasus serotina*). From 40 to 70 feet high and 2 to 6 and 7 feet in diameter; not very abundant nor of largest size except on the table-lands immediately below the Alleghany summits; wood fine-grained and valuable.

HARD OR SUGAR MAPLE (*Acer saccharinum*). On rich ground, 80 feet high; abundant all over the State, especially in the mountainous counties, where in several sections it constitutes half of the timber.

BLACK MAPLE (*A. nigrum*). Foliage darker and wood coarser than the preceding.

SWEET GUM (*Liquidambar Styraciflua*). A tall, slender tree, not often very straight, but with twisty wood that cannot be split; used for mill-work and carriage-hubs, and resists fire longer than any timber in the country.

SOUR OR BLACK GUM (*Nyssa multiflora*). From 50 to 60 feet high; on bottom-land; wood tough and twisted as the preceding.

BIRCH (*Betula*). The white, red, and sweet or cherry birch are represented in various parts, as on Elk River and tributaries, and on table-lands, where it grows 40 to 70 feet in height.

ALDER (*Alnus serrulata*). From 10 to 15 feet high; along river-banks.

WATER BEECH (*Carpimus Americana*). From 18 to 20 feet high, rough, intricate branches; wood tough, but not used.

IRONWOOD (*Ostrya Virginica*). From 30 to 40 feet high; wood tougher than hickory, and unsurpassed as a lever.

ASPEN (*Populus tremuloides*). Rare; not properly identified in West Virginia; grows 50 to 60 feet high in the central counties.

In a chapter on forest trees, shrubs, and medicinal plants, in the "*Resources of West Virginia*,"[1] the following additional species are mentioned as growing in this State:

BLACK ASH (*Fraxinus sambucifolia*). Grows 70 to 80 feet high, and 2 to 2½ feet in diameter.

BLUE ASH, (*F. quadrangulata*). Found mainly in Tennessee and Southern Ohio.

GREEN ASH (*F. viridis*). Usually grows 25 to 30 feet high, and 4 to 5 inches in diameter. Found most abundantly on the banks of the Monongahela and Ohio Rivers.

SWEET BUCKEYE (*Æsculus flava*). Grows 50 to 60 feet high, and is 2 to 3 feet in diameter.

COFFEE TREE (*Gymnocladus Canadensis*). Sometimes 50 to 60 feet high, and 1 to 2 feet in diameter, often clear of branches for 30 feet or more.

COTTONWOOD (*Populus heterophylla*). Not very abundant in this State.

DOGWOOD (*Cornus florida*). Rather a shrub than a tree; sometimes, however, growing 30 to 35 feet high.

BOX ELDER (*Negundo aceroides*). On bottom-lands along rivers, where the soil is deep, moist, and fertile, with locust, wild cherry, and coffee-tree timber. It is not long-lived, and used only for fuel. The heart-wood of old trees would afford a handsome cabinet-wood.

RED OR SLIPPERY ELM (*Ulmus fulva*). Widely diffused, but not abundant.

WAHOO (*U. alata*). A small tree, not over 80 feet high, and 9 or 10 inches in diameter; usually on river-banks.

FIR (*Abies Fraseri*). On the highest points of the Alleghanies, in Pocahontas, Pendleton, and Eastern Randolph.

HACKBERRY (*Celtis occidentalis*). Sometimes 80 feet high, with a trunk 18 to 20 inches. It prefers a cool, shady situation, and a deep, fertile soil, on the borders of rivers, and among other trees.

SILVER MAPLE (*Acer dasycarpum*). Grows 30 to 50 feet high, with a diameter of 2 to 4 feet and more. It is found in a sandy loam on the banks of the limpid rivers, with a gravelly bed, and is rare in miry, black soils.

RED MAPLE (*A. rubrum*). Grows 50 to 60 feet, and flourishes in the grounds that sometimes overflow, but west of the Alleghanies on high grounds, but of smaller growth.

RED MULBERRY (*Morus rubra*). Grows 60 to 70 feet, with a diameter of 2 feet.

SASSAFRAS (*Sassafras officinale*). Often grows 70 to 80 feet high, with a diameter of 3 feet.

SOURWOOD (*Oxydendrum arboreum*). Grows 15 to 40 feet high, and sometimes 2 to 2½ feet in diameter. It has a large proportion of sap-wood. It is not abundant, and grows in rich woods, along the Alleghanies.

The exportation of logs, ship-timber, staves, barrels, and lumber from West Virginia was computed, in 1870, at $2,500,000 in value annually. Of the 16,640,000 acres in the State, about 14,000,000 were unimproved, and about 9,000,000 or 10,000,000 in native forest. Reliable statistics are not obtained concerning the amount of forest within the reach of "raftable" streams. Single logs may be floated nearly

[1] A centennial publication by M. F. Maury and Wm. M. Fontaine, p. 430. The chapters on forests and timber are by Professor Fontaine.

from the sources of some of the rivers, and rafts upon the larger streams. The mountainous regions, however, do not admit of floating, the streams being rapid, tortuous, and rocky. The kinds mostly got for market are oak and tulip-poplar. The basins drained by Fishing Creek, Middle Island Creek, Little Kanawha and branches, Sand Creek, Great Kanawha, and its branches below the Great Falls, the Guyandotte and Big Sandy Rivers are mentioned as valuable timber-regions. The evergreens occur farther east, the largest pine region extending across Fayette and Raleigh, on both sides of New River, and some distance up the Gauley. Hemlock abounds most in the Cheat River and Greenbrier Mountains, and on the table-lands of Tucker, Randolph, Pendleton, Pocahontas, Nicholas, and Webster Counties. No oak, poplar, or hickory occurs here, but in their place the maples, ash, beech, birch, wild-cherry, and black-walnut. North, south, and east from the Staunton and Parkersburg turnpike, near the head of Greenbrier River, are extensive forests, which are being wasted and burned in clearing land.

In speaking of the distribution of timber in West Virginia,[1] Professor Fontaine recognizes three sections: the Mountain Region, the Plateau Region, and the Hilly Region (proper); the latter including the great body of the central and western portions of the State. The white, chestnut, black, and red oaks, chestnut, hickory, poplar, ash, sugar-maple, hemlock, beech, locust, and black walnut, occur generally in the Hilly Region throughout the State; some yellow pine is scattered here and there quite generally, as also the hemlock, but the home of both is most in the Plateau and Mountain Regions. It is said that there was once a considerable belt of yellow pine growing near the Ohio River, and some distance back; but this has disapeared, except a few scattered trees. There are indications that this tree was once much more abundant, for pine-knots are found in numbers where these trees do not grow. The hemlock seems to have crept down from the eastern highlands along the streams heading up in them, and to have maintained its position among them for a considerable distance within the deciduous timber of the Hilly Region.

Of the hard woods, the white oak is by far the most abundant, forming a third to a half of the timber of the State, and it is one of the most generally diffused. The oak, poplar, and chestnut appear to increase in size south of the Great Kanawha. In many parts of the Hilly Region we find the chestnut-oak on the ridges, large chestnuts on the hill-sides, and beech rather closely confined to the vicinity of the streams; we also find the black and sweet gums, buck-eye, white maple, white walnut, linden, cucumber-tree, and several species of maple, elm, and ash, the latter quite abundantly.

As we ascend the plateau the deciduous timber diminishes and becomes poorer, and evergreens increase; the oaks, poplar, and hickories giving place to walnut, cherry, chestnut, maple, and the conifers. Rising still further into the broad and lofty ranges of mountains at an elevation of 3,000 to 3,200 feet in the south and 2,500 in the north, and spreading east and west from this, we find the largest amount of evergreen timber in the State.

OHIO.

Mr. John Hussey, in an article on Forest Distribution,[2] after noticing that Ohio was situated between 432 and 1,300 feet of elevation above

[1] *Resources of West Virginia, pp.* 144–161; this article contains many details which we cannot include.

[2] *Ohio Agricultural Report*, 1872, p. 29. This article is accompanied by a list of trees found growing indigenous in Ohio, founded upon a list prepared by Prof. J. S. Newberry, in the Ohio Agricultural Report of 1859, and from various other sources.

sea-level, or practically, for the greater part, with a vertical range of only about 500 feet, and that there was no tree peculiar to the State, or any that even attained its greatest development within its borders, says:

We are situated on the border of the Northern and Southern region, and this we must bear in mind to understand the distribution of our own plants. We are situated on the verge of the cypress, a lumber tree of inestimable value in the South. This tree does not grow indigenous in our State, but in Southern Indiana, on the Wabash, and in Illinois, it attains a size scarcely inferior to what it attains in Louisiana. The cypress, unlike many other trees, will thrive with its roots and the lower part of its trunk wholly immersed in water. It may be cultivated in any low, wet place, where but few of our timber trees could exist at all. * * * The pecan grows a little farther north than the cypress; in fact, on our southern borders. The sweet-gum comes into our southern limits, but does not make a large tree. Both pecan and sweet-gum will grow, if planted, anywhere in Ohio. * * * The persimmon grows in the southern half of our State. The white cedar (*Cupressus thuyoides*) comes over our southern border, and the red cedar extends entirely across the State, but only in rare situations furnishes a trunk of sufficient size for any economic purpose. As we proceed southward, we find this tree showing signs of being in a more congenial situation by a larger growth. No farther south than the glades of Tennessee it makes a tree of good size for lumber. * * * On the northeast the hemlock spruce (*Abies Canadensis*) comes over our borders from the great forests to the northeast of us. This tree is found growing south of the 40th parallel in Indiana, in several localities, where it nearly joins the cypress from the south. In Parke County, on Sugar Creek, in that State, is the remnant of a hemlock forest; on the Wabash, a few miles to the south, is also the remnant of a cypress forest—some immense trees. These may point backward to a past chapter of our physical history, but, it would seem, in opposite directions. * * * The white pine * * * is not an important item among our forest-trees, on account of its scarcity and inferior size in this State. It is found in numerous localities in the northern part of the State.

The hills of Eastern Ohio form the outlines of the Allegheny Mountains. We may consider the sandstone bordering the Lower Scioto the beginning of the Appalachian system. The flora also indicates a change in the geological formations. The chestnut begins to be a common feature of the landscape; so common that it may be regarded as a characteristic feature of the sandstone region of the State. No tree makes a better promise of reward for cultivation than the chestnut in the porous soils derived from the sandstone of the eastern part of the State. * * * The *Magnolia acuminata*, or cucumber tree, grows a few miles farther west than the chestnut, and is suited to a more compact soil—that resulting from the decomposition of the black shale. This tree follows the line of the black shale throughout the State, and usually indicates the presence of a heavy soil. The pitch-pine marks the beginning of the sandstone almost equally well with the chestnut. It does not usually attain a large size, although it is extensively used where it can be obtained.

As showing our relations to the Allegheny uplift, I mention our broad-leaved evergreens which belong to the range of mountains to the east of us, but run along the spurs quite half way of the State; these are the *Rhododendron maximum*, the *Kalmia latifolia*, and, in the extreme south, the *Ilex opaca*; although this last does not characterize the spurs of the mountains as the two first mentioned. The laurels show by their growth that they are on the borders of their natural province. They continue to increase toward the center of the mountain-chain, where they make such compact and tangled masses that the hunter finds it easier to crawl over the interlaced tops than to make a path amidst the crooked and interwoven stems and branches, which bears alone can penetrate.

Coniferous trees in Ohio.

A large collection of sprigs of these trees, presented by Mr. E. Manning, at the Akron meeting of the Ohio State Horticultural Society in 1874, with a detailed account of his successes and failures in planting in Franklin County, Ohio, was made the basis of notes, written out by Dr. John A. Warder, and published in the transactions of the society.[1] They are applicable more particularly to Southern Ohio. We condense from these the following data concerning species found worthy of culti-

[1] *Transactions of Ohio State Horticultural Soc.*, 1874, p. 84.

vation, and such as were found otherwise. Referring to the report for details, we will simply classify them by name:

Hardy.

Pinus sylvestris.
Austriaca.
resinosa.
Pyreneaca.
strobus.
Abies excelsa.
Canadensis.
Picea balsamea.
Parsonii.
Juniperus Virginiana.
Cupressus thuyoides.
Thuja occidentalis.

Require some shelter.

Pinus larico.
Australis.
excelsa.
Abies Douglasii.
Abies Smithiana.
Picea pectinata.
pinsapo.
Taxus baccata.

Worthy of cultivation.

Pinus ponderosa.
Abies Menziesii.
orientalis.
Picea Nordmaniana.
Cephalonica.
Cupressus Lawsoniana.
Nootkaensis.
Taxodium distichum.
Thuja Siberica.
plicata.

Not sufficiently tested.

Pinus aristata.
Picea nobilis.
bracteata.
Pinus amabilis.
Retinosporus ———.

Of no great value.

Pinus inops.
Biotia orientalis.

May be used in ornamental planting.

Pinus Mugho.
pumila.
pungens.
flexilis.
alba.
Picea pichta.
Taxus adpressa.
Salisburia adiantifola.

HAMILTON COUNTY.—An experiment in tree-planting is cited by Dr. John A. Warder, upon the authority of Ezra Sherman, of the Whitewater village of the United Society at Preston, Ohio:

The seeds of locusts and cedars were planted in 1830. In three years the locusts were set out in a grove of 15 acres, at 12 feet distance from each other. An avenue was planted along a public highway for 200 rods in extent. Mr. Sherman considers that the stakes, poles, and pasture of this grove have been worth as much as it would have yielded if free of trees. (!)

In 1870 two-thirds of the trees along the road were cut down. These 180 trees made 1,500 posts, worth 35 cents each, or $525—that is, from $8 to $9 per tree. The stakes and top-wood were worth something besides. Some of the trees in the grove are considered worth $10 apiece, and the 15 acres thus stocked are expected to furnish fence-posts for the whole farm of 1,500 acres for all time. The cedars, though of much slower growth, are highly valued. They will make 8 posts, against 30 of the locust trees * * * After the first two years the borers were not troublesome.—(*Transac. of Kansas State Board of Agriculture*, 1873, p. 263.)

HOLMES COUNTY.—When this county was first settled, perhaps no part of Ohio produced a greater variety and superior quality of timber than was found growing among our hills. It was not uncommon to see growing on the hillsides and ridge-lands poplar trees 100 feet in height, and without a limb for 60 to 80 feet, carrying their thickness over three-fourths of their length. The principal varieties of timber are oak, poplar, sugar-maple, walnut, chestnut, beech, hickory, hackberry, pawpaw, dogwood, and iron-wood.—(*G. F. Newton* in "Essay on Holmes County." Ohio Agricultural Report, 1873, p. 220.)

This writer notices that since the clearing away of the forest there is a marked difference in the climate. The old-fashioned Indian summers have nearly disappeared, giving place to cold falls and early winters. He asserts that the winters are now a month to six weeks longer than they were thirty years before, and that the cold winds now come from the southwest.

In the session of 1873 efforts were made to secure an act of the legislature in Ohio to encourage the planting of trees, and a committee of the State Horticultural Society prepared a bill that was approved by many members; but it was found that the constitution forbade the exemption of private property from taxation under any pretext, and this circumstance hindered the enactment of the proposed law.[1]

[1] *Transactions of Ohio State Hort. Soc.*, 1874, p. 58.

LORAIN COUNTY.—As to relative abundance and importance the forests around Oberlin are about as follows:

1. The oak genus stands at the head; *Quercus alba* being most common.
2. Beech everywhere.
3. The hickories, led by *Carya alba.*
4. The maples. *Acer dasycarpum* being most abundant, and *A. saccharinum* most valuable.
5. Elms. *Ulmus Americana.* The *U. rubra* rare.
6. Ashes, white and black, and the basswood.
7. Liriodendron—a grand tree.

Other valuable trees are not very abundant. The *Platanus occidentalis* is common along streams and sandy places. The *Juglans nigra* and *S. cinerea* occur in some localities. The *Nyssa multiflora* occurs, as also the *Prunus serotina*, the black cherry, and the *Populus*, especially the *tremuloides*, which is common in swamps. The chestnut is scattered thinly over the county, more abundant on lake ridges, and about like the whitewood (*Liriodendron*) in quantity. The buckeye is found near streams, and some conifers (*Abies*, *Pinus*, and *Juniperus*), only a light sprinkling, along a few streams. Cottonwood grows occasionally, both wild and cultivated.

For shade-trees nothing surpasses the white elm, but the maples are more commonly set, especially the soft maple, and nowhere can finer specimens of these trees be seen than along the lake ridges in this county. The second growth comprises the same species and about the same abundance as the first. A few cedars spring up in place of deciduous trees. The soft maple grows rapidly on cleared lands, but in time it is reduced to its normal proportion.

The drainage is much more rapid since clearing—the streams now swollen and now dry—but no further changes noticed from clearings. There has never been any sweeping destruction, as where charcoal is made for a furnace. The use of coal for fuel has come in within five to ten years, and is now as common as wood. Much lumber is still cut, and will be as long as pastures (for dairying) are more profitable than forests. If woodlands were exempt from taxation the scale might be turned.

The size of the oak, elm, sycamore, and whitewood logs seen in our mill-yards is sometimes remarkable, those four and five feet in diameter being not rare, and oaks of six feet and more are known. A sycamore in Columbia Township is 33 feet 4 inches round.—(*Edwin S. Steele*, Oberlin, Ohio.)

PORTAGE COUNTY.—"In Aurora, Portage County, there is a farm where the shell-bark hickory has been allowed to grow in an old slashing. After twenty years these trees produced a profitable crop of first-class nuts; and the larger ones were cut for ax-helves and pick-handles. Old settlers of Stark County, Ohio, have told me that where, in 1800, there were openings covered with bushes not as high as a man's head, in 1850 the trees were few of them less than 50 feet in height."—(*Col. Charles Whittlesey*, Cleveland, Ohio.)

INDIANA.

This was originally for the most part a forest region, the prairies and oak-openings being relatively few and small. The surface is generally level in the northern part and more uneven and hilly in the south.

Forests of Southern Indiana.

In an essay by M. B. Kerr upon this subject, the writer, after remarking that the lands now in the tilled hill-country along the Ohio, would yield a much greater income if the timber had never been cleared, says:[1]

The farmers have discovered that by removing the underbrush and trash from their woodland, and sowing grass-seed, they can produce as good pasture as upon cleared fields; and no farm is complete without an abundance of good, well-shaded pasture.[2] * * * Many of the farmers of Dearborn County are now suffering great inconvenience from want of timber; some, having none at all, are compelled to buy at a heavy outlay for building and fencing, and are hauling coal many miles into the country for fuel, where twenty-five years ago a hundred cords per acre were burned in log piles to clear the ground. The poorest lands for cultivation are generally the most valuable timber lands, and would produce the best woodland pasture, and if such lands had not been cleared the timber preserved on them would have been worth more at the present time than all that has ever been realized off them, the lands in their present state included. This is about the average condition of Southern Indiana. The few isolated patches of timber now remaining on the farms have been culled of the best trees until they are of but little value except for fuel, and are so thin that they afford but very little resistance to storms, and are rapidly disappearing from being blown down and dying of wind-shake.

The velocity and destructiveness of wind-storms have greatly increased since the country has been so nearly denuded of its forests. In 1873 it was estimated that the corn crop in many counties was damaged 20 per cent. by the destructive storms of July and in the past year (1874) the damage to that crop was considerable in many places, The meadows, grain, and orchards suffer greatly from want of the protection once afforded by the forests, in shielding them from the bleak winds of winter and early spring. And it is an undoubted fact, that the droughts of summer are more frequent and protracted. Streams that on the average afforded mill-power nine months in the year, when the country was first settled, do not now afford it six months in the year; that is, the volume of water in the creeks seems to be diminished at least one-third. By this I would not wish to convey the idea that the general waterfall had diminished one-third, although our snows of winter and rains of summer are less frequent than they were twenty-five years ago. It is their irregularity that we complain of, rather than the diminished quantity. The cleared fields, openings, and well-washed ravines, affording no obstruction to the water, it passes off with much greater velocity than when most of the lands about the sources of the streams were heavily timbered; hence it is carried more rapidly out of the streams, and their flow is less regular. The radiations from the treeless hills and plains soon bring the ground to a parched condition; vegetation is checked, pastures are dried up, and field crops are cut short.

The effects upon the fruit crops are evident. In the first settlement of the country peaches seldom failed to produce a full crop; now they seldom do: failure is a rule, rather than the exception. The same causes affect the apples; the trees are longer in coming to the bearing state, the yield is becoming annually smaller, and the fruit less perfect. It makes but little difference which slope of the ground is taken to plant orchard or vineyard, unless there be a wind-break of forest. A bare hill gives no protection; the wind pours over it as water passes over a dam; but if the hills are capped with trees, the windy cascade is resisted. * * * But aside from theories, within the recollection of the writer, covering a period of about forty years, in this part of Indiana and through all Southern Ohio the summer droughts have become much severer and the streams visibly smaller, and we can attribute it to no other cause than destruction of forests without substituting a like agency.

In a report on the flora of the Wabash Valley below the mouth of White River, prepared by Dr. J. Schenck for the seventh geological report of Indiana, measurements are given of a considerable number of forest trees which, although now exceptionally large, can only be regarded as a remnant of a growth that was abundant when settlements began from fifty to seventy-five years ago. The wasteful destruction of such trees for a few pounds of wild honey, or for the crop of nuts on a pecan tree, has been frequent in former times, and may not still be unknown.

---

[1] *Indiana Agricultural Report*, 1874, p. 281.

[2] This practice will in the end prove ruinous to the forests, and should not be allowed where permanence is desired.—(H.)

Measurements of single trees in the Lower Wabash Valley.

Names.	Circumference at three feet from ground.	Height to first branch.	Total height.
	Feet.	*Feet.*	*Feet.*
Pecan (*Carya olivæformis*)	16	90	175
Black oak (*Quercus coccinea* var. *tinctoria*)	20	75	160
Burr-oak (*Quercus macrocarpa*)	22	72	165
White oak (*Quercus alba*)	18	60	150
Persimmon (*Diospyrus Virginiana*)	5½	80	115
Black walnut (*Juglans nigra*)	22	74	155
Honey-locust (*Gleditschia tricanthos*)	18	61	129
Catalpa (*Catalpa bignonoides*)	6	48	101
Mulberry (*Morus rubra*)	10⅓	20	62
Scarlet oak (*Quercus coccinea*)	20¼	94	181
Sassafras (*Sassafras officinale*)	7¾	75	95
Basswood (*Tilia Americana*)	17½	50	109
Bald cypress (*Taxodium distichum*)	18¾	74	146
Red maple (*Acer rubrum*)	13	60	108
Sycamore (*Platanus occidentalis*)	33⅓	68	176
Tulip tree (*Liriodendron tulipifera*)	25	91	190
White ash (*Fraxinus Americana*)	17½	90	144
Cottonwood (*Populus monilifera*)	22	75	170
Sweet gum (*Liquidambar styraciflua*)	17	80	164
Black hickory (*Carya tomento a*)	10⅓	55	112
Sugar maple (*Acer saccharinum*)	12½	60	118
Water oak (*Quercus palustris*)	12	23	120
Beech (*Fagus ferruginea*)	11	10	122

(*Seventh Report Geological Survey of Indiana*, p. 512.)

The Geological Reports, prepared under the direction of Prof. E. T. Cox, and direct correspondence, afford local items of information concerning the timber of many of the counties of this State which are worthy of notice:

Brown County:

This county possesses a large amount of valuable timber. The poplar and walnut trees, once common in the bottoms and on the loamy hill-tops, have been mostly cut and used, but of white and red oaks the supply is abundant, with a large surplus for export. A large amount of staves and hoop-poles are marketed, affording a precarious support to many. *Tan-bark* is a large source of revenue. The bark of the "chestnut oak" is found to be of superior quality for tanning, and is largely sought for that purpose. Leather prepared with this bark has taken prizes at Eastern fairs. The bark is sold on the trees at $1; cut and piled at $3 to $4, and brings $10 per cord at the railroad station in Columbus. Annual product, 20.000 cords. This species of oak grows only on the rich brown loam of the highest hills, does not survive in the valleys, and with the present wasteful consumption will soon cease to exist.—(*Sixth Annual Report of Geological Survey*, 1874, p. 105.)

Clay County:

On the upland the principal growth of timber is white, red, and black oaks, smooth, shell-bark, and mocker hickory, some ash, sugar-tree, and beech; on the bottoms, white, water, and burr oaks, gray ash, shell-bark hickory, red-bud, sassafras, dogwood. and pawpaw; along the streams, sycamore and cottonwood, and on the higher banks large black walnuts, three to five feet in diameter, and large burr oaks. There are at least five saw-mills on Eel River, in this county, cutting walnut lumber.—(*First Report*, 1869, p. 85.)

Franklin County:

This county was originally covered with a magnificent forest, comprising most of the hard-timber trees common to the latitude. A little more than one-half of the lands have been cleared and are now under cultivation, and in the remaining half a large amount of the best timber has been sawed into lumber or made into staves, so that good timber in the county is *comparatively* scarce, and is becoming more so every day. The principal timber trees are:

White oak (*Quercus alba*). This is, and always was, the most abundant tree in the county.

Burr-oak (*Q. macrocarpa*). Found in various parts, but nowhere abundant.

Chestnut oak (*Q. castanea*). Two miles north of Brookville, upon a poor point, there is a grove of about thirty trees; these are all I have ever seen in Southeastern Indiana.

Red oak (*Q. rubra*). Very common; black oak (*Q. tinctoria*), common upon the hills.

Beech (*Fagus ferruginea*). The red and white beech the most numerous of all trees except white oak.

The following trees also named: The shell-barks—thick shell-bark and pignut hickories, common; white ash, very common, valuable; blue ash, rather abundant and the most valuable of all ash timber; hoop-ash (*Celtis Mississippiensis*) and hackberry (*C. occidentalis*), quite common—the latter the most numerous; sycamore, plentiful along streams; butternut, quite common; tulip poplar, once very abundant, now becoming scarce; black walnut, formerly abundant, now becoming scarce; sugar, white, and red maples, common; wild cherry (*Cerasus Virginiana*), not abundant; sweet gum, common in the southern part, occasionally in the northern part; cottonwood (*Populus angulata*), quite common along the streams; basswood, very common; buckeye, abundant; coffeenut, not very abundant; honey-locust, gum, red elm, white elm, mulberry, common; red cedar, a few small groves. There are besides some other kinds, but they are seldom used for building or mechanical purposes, and are therefore not named.—(*First Report*, 1869, p. 195.)

Gibson County:

The finest growth of white oak and poplar timber that I have ever seen is found in a belt lying one to three miles north of Patoka. Trees 5 feet in diameter, with perfect trunks 50 or more feet high, were common, while monsters of much larger growth are not unusual. A giant hickory, northwest of Centerville, on section 8, T. 15, R. 9 W., was measured and found to be over 5 feet in diameter at three feet from the ground. The trunk was of great uniformity, maintaining that size to a height of sixty feet, without limbs, and for size, challenges its kind throughout the world. Choice unculled white oaks are abundant in the southeast corner of the county.—(*Third* and *Fourth Reports*, 1871–'72, p. 286.)

Huntington County:

This county was originally covered with a fine forest, but clearing the land for farming purposes and the conversion of trees into lumber have greatly reduced its area and stripped it of many of its finest representatives. Among the principal forest trees are white oak, poplar, black walnut, beech, ash, sugar-maple, burr-oak, red oak, elm, and some cottonwood on wet land. On the road to Silverville, 3½ miles northwest of Huntington, I measured a white-oak tree that proved to be 20 feet 3 inches in diameter [probably circumference] 4 feet from the ground.—(*Seventh Report*, 1875, p. 131.)

Jackson County:

Was formerly covered with a dense growth of forest trees, such as are usually found in this latitude. On the river-bottoms and champaign terraces the principal trees are poplar, black walnut, white oak, overcup oak, black oak, water-oak, beech, sugar-maple, water-maple, ash, hickory, elm, and sycamore. On the knobs and high table-lands, chestnut-oak, white oak, red oak, chestnut, sweet gum, hickory, poplar, black walnut, beech, and sugar-maple, the latter mostly on the hill-sides and in the ravines. There are 18 saw-mills cutting lumber, barrel-heads, and staves; one cutting 4,000 to 6,000 feet of poplar; another as much of beech, gum, and oak, &c.; others run on walnut, oak, &c.; and one cuts plow-handles, plow-beams, hoe-handles, wagon-felloes, chair stuff, &c. Wagon and buggy spokes, grain-cradles, snaths, &c., are made, and spokes are shipped to China. The hickory is sent to Hartford, Boston, and New York. There still remain some noble forest trees. On section 15, township 4, range 5, four poplar trees were measured that stood near together, the largest 38 feet around at 3 feet from the ground, and was 120 feet high and 65 feet to the first limb. The others were 18½, 18, and 17 feet around at 3 feet from the ground. On the same farm a red elm measured 18 feet around and a poplar 21½ feet. On Chestnut Ridge, a chestnut-stump was 9 feet 2 inches across. The knobs in the northwest part of the county are particularly noted for supporting fine forests of chestnut-oak. These trees flourish upon the most rugged sides of the ridges, and furnish the numerous tanneries of the district with their supply of bark. In the Carr settlement, on Pea Ridge, there are a number of large poplar, oak, and black-walnut trees, standing as witnesses of the former grandeur of the point. On the Hon. George W. Carr's farm, I saw the singular phenomenon of the limb of a dogwood tree, which was bent to the ground, and had taken root, and was growing vigorously. The parent tree is 8 inches in diameter and the Banyan-like limb 2 inches. This is the more remarkable, since it is difficult to transplant the dog-wood and have it grow under the most favorable treatment.—(*Sixth Report*, 1874, p. 69.)

JASPER COUNTY:

A narrow strip of deep, rich, alluvial soil, from one to two miles in width, along the southern margin of the Kankakee, is well timbered and highly productive. Groves and skirts of timber are found along the water-courses, which have been found sufficient to supply the demand for all purposes. Much attention is given to growing hedges, and soon the large farms will be inclosed by live fences of Osage orange, which, I am informed, succeeds well.—(*Third and Fourth Reports*, 1871–'72, p. 298.)

JEFFERSON COUNTY:

During the summer of 1873, in the prosecution of some botanical work in Southern Indiana, the writer was led to observe the size and character of the forest trees. Over a thousand trees were measured in this county (the measure of the diameter being taken at 3 feet above the ground), with the following results:

Trees.	Number of trees measured.	Average diameter.		Average height.
		Ft.	*ins.*	*Ft.*
Beech (*Fagus ferruginea*)	400	2	8	65
Red oak (*Quercus rubra*)	150	3	2	69
White oak (*Quercus alba*)	150	3	2	69
Tulip-tree (*Liriodendron tulipifera*)	150	3	6	87
Sugar-maple (*Acer saccharinum*)	100	2	6	70
Red maple (*Acer rubrum*)	75	2	6	70
Sycamore (*Platanus occidentalis*)	75	4	9	83
White elm (*Ulmus Americana*)	75	3	4	70
Buckeye (*Æsculus glabra*)	50	2	9	68
Yellow buckeye (*Æsculus flava*)	50	2	9	68

The largest tree in the county (*Platanus occidentalis*) measured at the base 13 feet 6 inches. Some 10 feet up, the diameter was 8 feet 4 inches, and 25 feet from the ground it was 6 feet. Its top had been broken off by storms. The beech and tulip tree attain a size at times that have not been seen in other parts of the State. Some of the latter are 8 and 10 feet in diameter. Of the former, 5 feet is not an unusual measure, and two have been seen over 6 feet. The beech is a very abundant tree in this part of the State, constituting at least 70 per cent.; but farther north the oak comes into prominent notice in their numerous species, forming at least 40 per cent. of the whole. Farther north the different genera become more evenly distributed. From a thorough observation of the forest trees of the county, the following percentages may be given:

	Per cent.
Beech (*Fagus ferruginea*)	35
Oaks (*Quercus*)	18
Tulip-tree (*Liriodendron tulipifera*)	10
Red maple (*Acer rubrum*) } Sugar maple (*A. saccharinum*) }	5
White ash (*Fraximus Americana*) } Blue ash (*Fraximus quadrangulata*) }	5
Black Walnut (*Juglans nigra*)	5
Hickory (*Carya alba*)	5
Sycamore (*Platanus occidentalis*)	3
Buckeye (*Æsculus glabra*) } Yellow buckeye (*Æsculus flava*) }	2
White elm (*Ulmus Americana*)	2
Other species	10
	100

In this calculation many of the less prominent trees were omitted.—(*C. R. Barnes*, Madison, Ind.)

JENNINGS COUNTY:

Was formerly covered with a very heavy growth of timber. The timbered lands of this county may be classed under two heads: First, the flats, which were originally covered with large, tall timber: White oak, beech, gum, soft-maple, burr-oak, hickory, and some other varieties, with a thick undergrowth in many sections, interwoven with native grape-vines. The undergrowth is the thickest on the wet flats, where the beech was almost entirely killed by the heavy frost of May 8, 1833. In some sections the tops of the white-oak timber were killed. The frost of that spring was late and severe, killing all the fruit in this section of the State, except a few late varieties of apples. Second, the rolling land, where the timber is white oak, black oak, beech, sugar, linden, ash, black walnut, white walnut, cherry, poplar, with an undergrowth on rich bottoms of pawpaw, and an occasional large sassafras. On the land of Joseph Hole, esq., bordering the South Fork, were two sassafras trees, the first measuring 4 feet in diameter, at 4 feet from the ground, the other something less. These trees stood near each other. The first was cut for saw-stocks and shingles; the top of the last cut, 40

feet from the stump, measured 3 feet in diameter. On the bottom lands, along the streams, sycamore, hackberry, elm, and buckeye flourish. These forests have, as a general thing, been stripped of the best timber. The white oak has been extensively cut for staves, the upper parts of the trees being left to decay upon the ground. In some sections the native forests remain untouched, and from these we can form some conception of their vigorous growth.—(*Seventh Annual Report Geological Survey*, 1875, p. 177.)

Orange County:

The varieties of timber found in the county being determined by the soils, may be divided into districts corresponding to the geological group into which the rocks are divided, each being characterized by some peculiarity either of growth or species, yet having many trees in common that seem to be adapted to all the kinds of soil. In the region underlaid by the Saint Louis limestones, formerly there was a heavy growth of that monarch of our forests, the yellow poplar (*Liriodendron tulipifera*). Next in size, and exceeding it in commercial value, comes the black walnut. Before these two trees had been so much cut away, it was not uncommon to see logs of the former that measured 5 feet, and of the latter 4 feet in diameter. The following are common and of good size: White walnut, sugar and red maples, buckeye, hackberry, red and white elms, shell-bark hickory, mocker nut, thick shell-bark hickory, pig-nut, white, red jack, burr, black, and chinquapin oaks, white ash, and wild cherry (*Prunus serotina*). Along the streams are a few sycamores and water-beech (*Carpinus Americana*). The undergrowth is remarkable for its size, so that the woods present a very open appearance, even in the wildest places. This growth is made up of the dog-wood, red buds, crab-apple, and sassafras. The shrubs are spice-bush (*Lindera benzoin*), wahoo (*Euonymous atropurpureus*) and pawpaw (*Asimina triloba*). In the cherty and more rocky parts there is an increase of small timber and shrubs, and the undergrowth is very dense. Here we find the wild *Pyrus Americana, Crategus coccinea, C. tomentosa, Viburnum prunifolium,* and *Corylus Americana.*

The timber found growing in the chester sands includes yellow poplar, black and white walnut, the oaks, hickories, cherry, and ash of those enumerated above, and in addition beech and American aspens. On the high ridges are fine specimens of chestnut, and in the open ground persimmon. In this region the growth is vigorous, and the yellow poplars are very common. The warm sands seem well adapted to the growth of this tree, and dealers claim that the lumber made from it is superior to that from timber grown in the bottoms. The black oak, in bodies, is confined to the conglomerate formation, where the barrenness of the soil shows its influence especially on the young hickories; yet even here the yellow poplars and white oaks grow to be giants, but not in so great numbers as in more favorable localities. In the lacustral clays we saw a few specimens of sweet gum. The beech is very peculiarly adapted to these heavy soils. In Stamper's Creek Township we saw whole groves in which the yellow poplar never grows. Among the rare trees, we heard of a single cucumber tree. (*Magnolia acuminata*), and saw a few winged elms (*Ulmus alata*).—*Seventh Report*, 1875, *p*. 237.

Owen County:

Mention has been made of choice forests in different parts. These comprise all the best varieties found in the State. The growth is exceptional. Specimens of oak were measured at several stations, 4, 5, and 6 feet in diameter, with trunks straight as an arrow, without limbs or fault, 50 to 80 feet long. Some poplar trees are still larger; all of perfect growth, without shake or knot. Such timber is valuable, and should be used only by skillful workmen for mechanical objects.—(*Seventh Report Geological Survey*, 1875, p. 358).

Parke County embraces in its forests nearly all the desirable timber trees of the State. Its flora embraces the varieties of the prairie as well as of the woodlands. The poplars, oak, walnut, ash, cherry, sycamore, hickory, maple, beech, and elm, are found in their several varieties for this latitude, and in some portions of the county attain a height, symmetry, and diameter unsurpassed in the State. Florida Township: The white and burr oak, and the poplar, are the leading timbers of this township. The walnut is found where the lumberman has not been. The canal on the west, the railroad on the east, and the prairie demand from Illinois have depleted the timbers in this section of the county; other towns specified but not differing materially in details. In Jackson Township a white oak at 2½ feet above the ground, was 16 feet 10 inches around, and another 18 feet.—(*Third and Fourth Reports*, 1871–'72, p. 379.)

Perry County:

The large forest trees that were within easy reach of the river have mostly been cut down and converted into lumber, but in the interior, and especially in the northern part, there are tracts of land with scarcely a tree destroyed. The trees are very large and fine, and are of every variety found in this latitude; those most numerous and suitable for lumber are poplar, black walnut, white walnut, ash, oak, cherry, beech,

and sycamore. In addition to those most useful for lumber, there are large hickories, elm, backberry, sassafras, persimmon, and occasionally buckeye trees.—(*Third and Fourth Reports*, 1871–'72, p. 141.)

POSEY COUNTY:

This county averages from 350 to 450 feet above tide. It is undulating, except on the Wabash bottoms, and some smaller river-bottoms. The soil of these is a sandy loam, but on the uplands more clayey, with marl in places, of the Quaternary age. Prevailing timber, tulip, beech, sugar-tree [maple], hickory, white and black oak, black and white walnut, elm, &c. In several cases, a second growth when allowed to come up, has consisted almost exclusively of black-jack oak. In another case it was nearly all tulip-tree. Within the last fifty years the springs have very much dried up, and the surface-water runs off much more rapidly, so that we suffer from drought in various ways more than formerly. The wind, too, has a greater sweep, and hurricanes have been more frequent, with consequent injury to grain as well as to the timber yet left. The rise in the rivers is also much more rapid than formerly. Few experiments in forest planting have been tried. Some farmers have carefully culled their rail-timber and fire-wood where the trees were thickest, and have thus made a forty-acre lot serve a good sized farm. Thomas Say, the naturalist, who accompanied Major Long in his expedition to the Rocky Mountains, brought home and planted the *Kœlruteria* (one of the *Sapindaceæ* of botanists), which has since been extensively cultivated as a shade-tree with great success. Osage hedges are quite abundant through the county, and are found to be a great protection against the wind, as well for orchards as for fields. Some timber in this county has been destroyed by hurricanes, and a considerable amount of our hickory we find injured by the borer.—(Prof. *Richard Owen*, New Harmony, Ind.)

RIPLEY COUNTY had originally a very heavy growth of timber. In sections of the northern part the growth is almost exclusively white oak; in other sections exclusively larch, while in other localities the two are combined and interspersed with other varieties. The forests on the "flats" are remarkable for the abundance and size of the trees, and the occasional thick undergrowth woven together with grape-vines, which add much to the density of the woods. The cutting of white oak for staves has deprived these forests of their best timber, yet some groves of wood which have been preserved bear testimony to large and abundant growth of the primitive forests. The timber on the rolling land and along the streams is poplar, black and white walnut, white oak, black oak, water-oak, gum, hackberry, ash, water-maple, elm, sycamore, &c. * * * There are at present twenty saw-mills in the county. The approximate amount of lumber cut the past year is 2,000,000 feet. It was estimated that 5,000,000 were cut in 1873.—(*Seventh Report Geological Survey*, 1875, p. 201.)

SCOTT COUNTY:

In former days this county was heavily timbered, and various sections afforded all the varieties of merchantable lumber. The principal use made of timber at this time is to cut it up into cooper-stock. Quite a number of mills are engaged in cutting staves for "tight-work"—coal-oil barrels and pork-barrels, and for "slack-work"—cement and flour barrels. One mill is mentioned as cutting 700,000 slack-barrel staves, using sugar-maple, beech, oaks, &c. Another cuts 500,000 white-oak staves for oil and pork barrels, and pays $18 per M for sound staves. Another cuts 700,000 to 800,000 staves, and makes 40,000 to 50,000 barrels.—(*Sixth Report*, 1874, p. 132.)

VANDERBURGH COUNTY:

The forests of this county * * * afford one of the great sources of income. Ornamental woods, as walnut, oak, maple, beech, ash, &c., are common, and several of the most prosperous manufacturing establisments are engaged in converting this home-material into useful and ornamental purposes. Other kinds of timber are used for building purposes, the manufacture of wagons, carriages, plows, implements, and machines. The sales, direct and indirect, credited to the forests, amount annually to over $4,000,000.—(*Seventh Report*, 1875, p. 295.)

VERMILLION COUNTY:

At the first settlement of the country the bottoms were heavily timbered, but a large part of the terrace was so-called prairie, being entirely clear of trees. It is probable, however, that this was the result of ancient clearing by the Aztecs or Mound Builders, whose mounds are quite numerous in this region, and that during the period when the Indians occupied the country, their annual fires prevented the growing up of the clearings. * * * The slopes of these bluffs are generally too steep for convenient cultivation, and are, through nearly their whole extent, still heavily covered with timber, principally consisting of oaks, hickories, and walnuts, though beech begins to take a prominent place as we approach the southern end of the county. In many of the ravines, and along the foot of bluffs, there are large groves of sugar-maple, from which considerable quantities of sugar and molasses are annually drawn. Near the

principal stream this timbered region extends westward to the State line; but in both the northern and middle portions of the length of the county, considerable portions of its territory form parts of the Grand Prairie, which stretches, with few breaks, northward to the Illinois River and westward nearly to the Mississippi.—(*First Report*, 1869, p. 139.)

VIGO COUNTY contains the usual variety of trees found in this latitude. Many of the large black walnut and poplar trees have been converted into lumber, and vast tracts of timber-lands are annually cleared for cultivation, but a noble forest yet remains on portions of the uplands.—(*First Report*, p. 114.)

WASHINGTON COUNTY:

Our most valuable timber is the poplar, of which about 80 per cent. has been used. Next in value is black walnut, used for furniture, of which about 85 per cent. has been disposed of. Of the oaks, about 70 per cent. has been used; and next, the hickory, of which half remains. Of the white and gray ash, 80 per cent. has been used, as has been nearly all the wild cherry. Of the sugar-maple, four-fifths has been cut off, for lumber and cord-wood.—(*Lewis J. Reyman*, Salem, Washington County, Indiana.)

WHITE COUNTY:

Sufficient for past and present wants has been obtained in the oak-openings and along the streams. East of Monticello, I am informed, timber is abundant, and of excellent quality.—(*Third and Fourth Reports*, 1871–'72, p. 302.)

ILLINOIS.

According to a list prepared some years since by Dr. George Vasey (now botanist in the Department of Agriculture), the number of species of native forest-trees growing throughout this State is 61; the number peculiar to the northern part of the State is 6, and the number peculiar to the southern part is 14, making the total number of native species 81.[1] To this number there have since been added as peculiar to Southern Illinois.

---

[1] I.—OCCURRING THOUGHOUT THE STATE.

Liriodendron tulipifera (*Yellow Poplar*).
Asimina triloba (*Pawpaw*).
Tilia Americana (*Basswood*).
Æsculus glabra (*Buckeye*).
Acer saccharinum (*Sugar Maple*).
  dasycarpum (*Silver-leaf Maple*).
  rubrum (*Red Maple*).
Negundo aceroides (*Box-Elder*).
Cercis Canadensis (*Red Bud*).
Gymnocladus Canadensis (*Kentucky Coffee-tree*).
Gleditschia tricanthos (*Honey Locust*).
Prunus Americana (*Wild Plum*).
  serotina (*Wild Black Cherry*).
Cratægus coccinea (*Scarlet Thorn*).
  tomentosa (*Long-pointed Thorn*).
  crus-galli (*Long-spurred Thorn*).
Pyrus coronaria (*Wild Crab Apple*).
Cornus florida (*Flowering Dogwood*).
Nyssa multiflora (*Black Gum*).
Viburnum lentago (*Sheep Berry*).
Diospyros Virginiana (*Persimmon*).
Fraxinus Americana (*White Ash*).
  pubescens (*Red Ash*).
  viridis (*Green Ash*).
  sambucifolia (*Black Ash*).
  quadrangulata (*Blue Ash*).
Sassafras officinale (*Sassafras*).
Ulmus fulva (*Red or Slippery Elm*).
  Americana (*White Elm*).
Celtis occidentalis (*Hackberry*).
Morus rubra (*Red Mulberry*).
Platanus occidentalis (*Sycamore*).
Juglans cinerea (*Butternut*).
  nigra (*Black Walnut*).
Carya olivæformis (*Pecan*).
  alba (*Shell-bark Hickory*).
  sulcata (*Ribbed Hickory*).
  tomentosa (*Mockernut*).
  porcina (*Pignut*).
  amara (*Bitternut*).
Quercus alba (*White Oak*).
  obtusiloba (*Post-Oak*).
  macrocarpa (*Burr Oak*).
  bicolor (*Swamp White Oak*).
  castanea (*Chestnut Oak*).
  imbricaria (*Shingle Oak*).
  nigra (*Black-Jack*).
  coccinea (*Scarlet Oak*).
  rubra (*Red Oak; Black Oak*).
  palustris (*Pin-Oak*).
Fagus ferruginea (*Beech*).
Ostrya Virginica (*Hop-Hornbean*).
Carpinus Americana (*Iron-Wood; Blue Beech*).
Betula nigra (*River Birch*).
Salix nigra (*Black Willow*).
Populus tremuloides (*Aspen*).
  grandidentata (*Large-toothed Aspen*).
  monilifera (*Cottonwood*).
Pinus strobus (*White Pine*).
Thuja occidentalis (*Arbor Vitæ*).
Juniperus Virginiana (*Red Cedar*).

The following native trees prove hardy in Central Illinois: American aspen, box-elder (adapted to a great variety of soils, ornamental as a shade tree, and thrifty almost everywhere); black and white ash (of varied capacity as to soil, but not so rapid in growth); mulberry (timber durable for posts); sugar-maple; black walnut, (must be planted where grown, as it does not bear transplanting); butter-nut; cottonwood (objectionable from too much seeding); white flowering dogwood (not sufficiently appreciated); hackberry (valuable, adapts itself to a great variety of soils); Judas tree; June-berry; Kentucky coffee-tree (rapid in growth, free from insects, wood durable, and valuable for shade); pecan; persimmon (adapted to many varieties of soil and location); red elm; soft maple, (planted more than it deserves, as it is short-lived and wood of poor quality), and elm.

Of trees not native the following observations have been made: Austrian pine, (has a rank growth, but has recently suffered from an insect); balsam fir, (needs low moist soil, liable to suffer from drought); catalpa, (capacity limited); chestnut, (must be planted where it is to grow); deciduous cypress, (merits more attention); European larch, (is *the* tree for cultivation, growing on a great variety of soils, must be transplanted when small); European linden; purple fringe-tree; horse-chestnut; Lombardy poplar, (rapid grower, but wood perishable); Osage orange, (for hedges without a rival); Scotch pine (perfectly hardy, a free grower, and not injured by insects, is especially valuable as a wind-break); and American barberry, (deserves more attention as a hedge-plant).

The following kinds are failures: Abele, ailanthus, arbor vitæ, mountain ash, Chinese arbor vitæ, junipers, box, hemlock, Kilmarnock willow, mountain laurel, Norway spruce (short-lived), white pine, and holly. The beech has not been sufficiently tested.

A prominent cause of failure in evergeen planting is the exposure of the roots to the sun and air. "We have seen hay-racks loaded with evergreens going from the nursery to the packing-house that were dead before shipping, proving worse than a total loss of money to the purchasers." The pear grafted on quince stock has also led to great disappointment.

The importance of tree-culture is not fully appreciated in the prairie regions of Illinois, and its effect upon the rain-fall is not enough understood. In this country, for several years past, the crops on lands near our rivers and wood-bounded streams have suffered seriously from excessive rain-fall, while more open and extended plains have had less than an average. As an observer from the Signal-Service of the

II.—PECULIAR TO NORTHERN ILLINOIS.

Prunus Pennsylvania (*Wild Red Cherry*).	Betula papyracea (*Paper or Canoe Birch*).
Ulmus racemosa (*Corky White Elm*).	Pinus Banksiana (*Scrub Pine*).
Betula lenta (*Cherry Birch*).	Larix Americana (*Tamarack*).

III.—PECULIAR TO SOUTHERN ILLINOIS.

Magnolia acuminata (*Cucumber-tree*).	Catalpa bignonoides (*Wild Catalpa*).
Robinia pseudacacia (*Wild Black Locust*).	Ulmus alata (*Winged Elm*).
Gleditschia monosperma (*Swamp or Water Locust*).	Celtis Mississippiensis (*Mississippi Hackberry*).
Pyrus angustifolia (*Narrow-leaved Crab-Apple*).	Quercus falcata (*Spanish Oak*).
Liquidambar styraciflua (*Sweet Gum*).	Populus heterophylla (*Swamp Cottonwood*).
Viburnum prunifolium (*Black Haw*).	Taxodium distichum (*Southern Cypress*).
Bumelia lycioides (*Buckthorn*).	Quercus lyrata (*Southern Overcup Oak*).
lanuginosa (*Southern Buckthorn*).	Nyssa uniflora (*Large Tupelo*).
	Cratægus arborescens (*Tree-like Thorn*).

War Department, we have given this matter close attention, in its connection with the horticultural interests.—(*J. Cochrane*, Havana, Mason County, Illinois.)

A committee of the Northern Illinois Horticultural Society, at a session held in December, 1867, recommended the following list of evergreens as suitable for cultivation in that region:

For timber-belts: White pine, Norway pine and spruce, Scotch pine, Austrian pine, and American arbor vitæ.

For high screens: Norway spruce and American arbor vitæ.

For screens of moderate height: Siberian arbor vitæ, Norway spruce, American arbor vitæ, hemlock, and red cedar.

Ornamental specimen trees: All the foregoing, and the white, black, and red spruce, *Picea pichta*, Cimbrian pine, *Pinus mitis*, Irish and Swedish junipers.

Shrubs: American yew, tamarix-leaved and Waukegan trailing juniper, savin, *Pinus magnus*, *Pinus pumilis*, and *Andromeda floribundi.*

An experimental station, begun at the Illinois Industrial University, reported, February 29, 1872, 7 acres as planted with 36,749 trees, at a cost of $433.48 for trees, $106.72 for planting, and $42.83 for cultivation; total, $583.03. The kinds planted were the white and green ash, catalpa, chestnut, white elm, European larch, white maple, Osage orange, Austrian and Scotch pines, white walnut, and white willow. The land planted with each kind was generally a quarter of an acre, but more with white ash and larch. Distance apart, 2 by 4 inches, except the pines, which were 4 by 4. The catalpas and white elms were all living, and but 2 per cent. of the green ash, white maple, Osage orange, and white willow died. But 1 per cent. of white walnuts and 5 per cent. of white ash were lost. Half the chestnut and three-fourths of the larch perished, and but 2 per cent. of the pines lived. The white grub (the larva of the May beetle) did great injury, especially to the larch and white ash, girdling the roots below the surface. The loss of the pines was attributed to dry weather.[1]

In 1872, 10,083 trees were planted; the larches and pines from R. Douglas & Sons, Waukegan, Ill., and the others grown on the premises at Champaign. The percentages living from both years' planting, at the end of 1872, were as follows: Catalpa and white elm, 100; white walnut, 99; green ash, white maple, white willow, Osage orange, and Norway spruce, 98; white ash, 93; European larch, Austrian pine, and white pine, 30; Scotch pine, 20; chestnut, 4. The white grub had again done much injury, especially to the larch. It was found to be less affected on high land. The chestnuts mostly winter-killed. The Osage orange was promising to become one of the most valuable trees for that latitude, and both this and the catalpa, when cut close to the ground in order to get a good straight growth, had succeeded well.

Notes on the cultivation of some of the more valuable deciduous forest-trees of Illinois, by Arthur Bryant, of Princeton, Illinois.[2]

It is remarked by Mr. Bryant that deciduous trees make up the native forests of Illinois, the few pines and cedars that occur not being worth taking into account. To produce tall, straight, clean timber, it must be grown thickly while young, and lands designed for timber-planting should be plowed, harrowed, and marked out in rows four feet apart.

The most important class of deciduous trees in the country was that of the *Cupuliferæ*, including the oaks, chestnut, and beech. The most valuable species are the white oak, burr oak, swamp white oak, post oak,

[1] *Fifth Report of Trustees of Illinois Industrial University, p.* 95.

[2] *Transactions of Illinois State Horticultural Society*, 1870, *p.* 124.

and chestnut. The seeds should be gathered as soon as ripe, mixed with damp sand before becoming dry, packed in boxes, put in a cool place on the north side of a building or fence, and covered with earth, securing them against rats and mice. They should be planted as early as possible one foot apart in the rows. The seeds of the oaks should be planted where the trees are to remain. The young plants should receive clean culture until they are too large to be smothered by weeds. If they are to be removed, it is best to sow in seed-beds, and transplant when one, or, at most, two years old. The chestnut is sometimes killed to the ground the first winter in Northern Illinois. This should be guarded against by ridging up the rows with a plow late in the autumn, or by covering with litter. It is rarely if ever injured by cold after the first winter.

Among the oaks of Illinois the white oak (*Quercus alba*) is unquestionably the most useful, and it is also diffused in the greatest abundance over the country. There are in the State many tracts of broken land, mostly near streams, which are covered with young trees, principally oak, that only need presevation to become in time valuable timber.

The burr oak (*Q. macrocarpa*) appears to be a stranger to the Atlantic States. It grows in richer soil than the white-oak, and its wood is, for most purposes, equally valuable. It is more durable when used for posts, but its pores are more open, so that it is not used for casks intended to contain liquors.

The swamp white oak (*Q. prinus* var. *discolor*) occurs in low moist land. Its wood resembles that of the white oak, and by some is considered equally valuable, but is much less common.

The post oak (*Q. obtusiloba*) is common in Central and Southern Illinois, and is said to be found throughout the State, but Mr. Bryant had not met with it in the northern part. It will thrive on very poor soils. The wood is heavier, stronger, finer grained, and more durable than that of the white oak. It is a middle-sized tree, and rarely affords timber of any considerable length. The superior quality of its wood renders it well worthy of cultivation.

The chestnut is not a native of Illinois, but will grow in every part, thriving in almost any soil that is not too wet. The wood is more durable than white oak for fence-posts, and is much used for cabinet-work and for inside finish of houses, railroad-cars, &c. When cut in winter, a grove of chestnuts will reproduce itself from the stumps in fifteen or twenty years. These suckers grow with astonishing rapidity, and need no care but the exclusion of cattle and occasional thinning. Unquestionably it might be planted profitably for the fruit, and for this purpose the trees should be planted 15 or 20 feet apart.

Ash trees come next after the oaks as important for general use. The seeds of the different species ripen about the first of October, and should be mixed with moist sand and laid aside till spring. They may then be sown in seed-beds, and the trees transplanted when one or two years old in places where they are to remain. Two feet apart is the proper distance to set them.

The white ash (*Fraxinus Americana*) attains its greatest development in cold climates, and its wood is valuable for many uses. It grows faster than the oak, and is one of the trees in which the most rapid growth produces the best timber. It is every way worthy of extensive culture.

The blue ash (*F. quadrangulata*), unknown in the Atlantic States, is found in the West in rich soils, not growing as large as the white ash, but its wood quite equal in value. South of 40° it would be more eligible for cultivation than the white ash.

The black ash (*F. sambucifolia*) commonly grows in wet soils. The wood is tough and elastic, and the concentric circles are easily separated, thus forming an economical material for hoops.

The red ash (*F. pubescens*) and green ash (*F. viridis*) afford timber similar in quality to the white ash, but of smaller size.

The walnut family ranks next. The nut should, before dry, be laid in heaps on dry ground, covered with straw, and over this 3 or 4 inches of earth. They should be planted in spring like acorns, except that black walnuts and butternuts should be placed 2 feet apart. Hickories should grow 1 foot apart, till some are large enough for hoop-poles.

The black walnut (*Juglans nigra*) is of rapid growth and easy culture, and, from the value of its wood, promises greatest profit. It should be planted by itself, as it is a bad neighbor, and fruit-trees near it soon perish.

The butternut (*J. cinerea*) grows further north than the black walnut, and its wood, although less valuable, is still worth cultivation. The wood is used for cabinet wares and for inside finish to houses.

The English walnut (*J. regia*) is valuable for its fruit where it will endure the climate, which is not in Northern Illinois.

Of the hickories, the kinds most valuable for timber are the shellbark (*Carya alba*) and pignut (*C. porcina*). The latter affords the longest wood of all the hickories, though their characteristics are very much alike.

The sugar-maple (*Acer saccharinum*) and black maple (*A. nigra*) are valued for the production of sugar and for fuel. The seeds ripen in autumn, and should be treated as those of the ash. The young trees grow slowly at first, and should remain in the seed-bed two or three years. The silver maple (*A. dasycarpum*) and red maple (*A. rubrum*) ripen their seeds late in May, and must be gathered and sown immediately. The wood of these and the box-elder (*Negundo aceroides*) is not of the best, but their rapid growth renders them desirable to plant where speedy result is wanted.

For the management of young plantations of timber only general rules can be given, and the exercise of judgment and common sense on the part of the cultivator is necessary. Thinning should be done in time to prevent the growth of trees from being checked by crowding, and the poorest trees should be first removed. No tree should be allowed to fork. All dead and sickly branches should be cut out, and after the trees are 10 to 12 feet high they should be kept clear of the branches for from one-half to two-thirds of their height. With proper care nearly every tree in a well-grown plantation will be of value for timber.

Stock of every description should be excluded from plantations of trees. Woodlands of natural growth, intended to be permanent, should likewise not be pastured. They will continually reproduce themselves, if young trees are allowed to grow, but any forest will be in time destroyed by a persistent course of pasturage. Many landholders in Kentucky formerly adopted the practice of cutting the least valuable trees from their woodlands, sowing blue-grass and pasturing them. Very fine parks were produced; but for twenty years past the old trees have been fast dying out, and no young ones exist to take their places.

Experiments of D. C. Scofield in Tree-planting, at Elgin, Ill.[1]

This plantation was begun in 1858, with imported and American seedlings and seeds; and is on a rich, dry, undulating prairie, with black loam passing into clay at a depth of 4 to 6 feet, where it is underlaid by coarse gravel. It consisted, at first, of about 12,000 trees; 8,000 set from 1858 to 1862, and 4,000 in 1866. The plants were usually from 8 to 12 inches long, were transplanted in nursery-rows, and in two years to their permanent places. The ground had been cultivated three years from prairie sod, and was well pulverized. The planting was done in furrows of proper depth, level places of proper depth being prepared by the spade, and care being taken to prevent drying of the roots. The larch (forming the greater part) were 2 to 4 feet high when transplanted, and the evergreens 1½ to 3 feet. Having been transplanted once or twice in the nursery, they were well stocked with roots. They were cultivated three to six years, and beans planted in the wider spaces; and from this time, excepting the black walnuts and elms, they protected themselves. These and the white ash needed longer cultivation on account of later leaving.

The varieties planted were the Scotch, black Austrian, and white pines, Norway and white spruces, American and Siberian arbor-vitæ, hemlock, and European and American silver fir; and of deciduous trees, the black walnut, silver-leaf, sugar, and red maples, box-elder, English, red, and white American elms, chestnut, horse-chestnut, European mountain-ash, white ash, redbud (of Southern Illinois), European and American larch, and cypress.

European larch.—This is now 28 to 32 feet high, with diameters varying according to density, the most being 14 inches at 1 foot from the ground. Nearly every tree grew; average annual growth the first nine years, 2½ feet. On the 19th of October, 1869, a severe frost, coming before the tops had hardened, checked them, and the gain was not over 2 inches a year, or a foot in six seasons, till 1876, when they grew 18 inches. No bird or insect has attacked them.

[1] Communicated to the Horticultural Society of Northern Illinois, and published with the *Transac. of Ill. Hort. Soc.*, 1876, p. 284.

Black walnuts grew so long as cultivated, but when exposed, from the dying out of a row of soft maples, and by the encroachment of sod, they became stunted in growth, except a few that grew in a depression, equally dry with the rest, but of richer soil, where the trees were now 20 to 30 feet high and 12 to 16 inches in diameter. A block of black walnuts, 3 by 16 rods, in rows 4 feet apart and 2 feet between in the rows, was cultivated eight years and then left. Some of these, in a basin of vegetable mold, are now 4 to 6 inches in thickness and 20 to 25 feet high. The rest are 2 to 4 inches in diameter and 15 to 20 feet high, the average amount of wood-growth being one-fifth of those in the basin. A neighbor had planted walnuts, in 1844, that had been transplanted twice. They were 20 feet apart; had been in cultivated ground twenty-five years. They are now 17 inches thick at 2 feet from the ground, and one that had been cultivated till now on one side was 23 inches, with a height of 40 feet. These trees have a spreading top, the branches beginning at 7 to 8 feet up, and bear fruit abundantly.

These facts lead to the conclusion that black walnut will succeed on dry, rich soil, if cultivation is continued till the trees are able to shade out the grass, and that when planted alone, and without shading nurses, they will die. Mr. S. prefers the European larch as a nurse. The sugar-maple is found to agree well, and might be used for this purpose. These other trees secure a clean, upright stem to the walnut, an important object with this timber. It must have deep, rich soil.

Silver-leaf maple.—This promised well everywhere ten or twelve years, and some trees had a diameter of 18 inches at the collar in 15 years. They are liable to break from winds in summer and from ice in winter, and many show signs of early maturity and decay. They are particularly liable to injury from grass. It grows best in wet soils.

White ash.—Trees set in 1856, 1 inch in thickness and 7 feet high, 2 rods apart, are now 30 feet high, 8 to 14 inches thick, and the spread of the limbs 20 to 25 feet. They have a strong tendency to sprout from the stump of the parent tree. Trees from seed, planted in 1858, and set in forest rows, with European larch and black walnut, are straight and smooth 25 to 30 feet high and 3 to 4 inches in diameter.

Sugar-maples, planted 20 feet apart, 7 feet high, in 1856, are now 25 feet high and 6 to 8 inches thick, spreading 12 to 17 feet.

Trees from seed, planted in 1858, have a height of 20 feet and thickness of 3 to 6 inches. It grows very slow in prairie soil for fifteen to twenty years, after which it makes satisfactory growth. Trees an inch in diameter when set, thirty-three years ago, are now over 3 feet in circumference at a foot from the ground, 30 feet high, and 25 feet spread. A wild-cherry tree, set in the same ground, twenty-six years from seed, is now 5 feet around.

Box-elder grows rapidly, gaining a diameter of 6 inches in seven years from planting, and forms a fine head, 16 feet across. It is not liable to break from winds and ice, like the soft maple.

Butternut grows well under cultivation, being 5 to 7 inches through, and a well-proportioned head. It bears nuts.

Redbud, good only for ornamental planting; slow grower.

American larch grows nearly as well as the European, but with less regular form; branches, wild and straggling; height, 25 feet; diameter, 4 to 6 inches.

Red elm grows rapidly, some trees being 6 to 8 or 10 inches thick; but at this age many have an unhealthy appearance. It is not worthy of cultivation on dry land.

White elm.—In regard to growth, variety of soil needed, and habit of late leaving, it resembles the walnut, requiring the same treatment, and leading to the same results. Valueless on common prairie without cultivation until able to protect itself. There is this difference between these two trees, however, that while the walnut requires a deep, rich, dry soil, the white elm will flourish in a wet soil, less deep and rich, with annual cultivation for twenty years. These two trees make about the same growth on common dry prairie as they do in the "sinks," with a cultivation of four or five years.

English elm makes a more vigorous growth and a more beautiful foliage than either of the American varieties, and will do well with less cultivation.

Chestnut.—A total failure on prairie soil. Only one tree remained on the ground, and this is the only one known in the county. It stands 20 feet high, 6 inches in diameter, and is kept in slightly growing condition from the forest protection around it. It grows satisfactorily on the lighter soil of the Mississippi bluffs.

Lombardy poplar grows rapidly and beautiful a few years, but is unhealthy and valueless in ten or fifteen years, especially so on rich soils. Trees of ten years' growth are 8 to 10 inches thick and 25 to 30 feet high.

Horse-chestnut.—Hardy, but an exceedingly slow grower on prairie, yet grows well on gravelly or sandy soil.

EVERGREENS.—*White Pines* are 30 to 40 feet high in forests 6 to 8 feet apart, with a diameter of 10 to 14 inches. When close, they are of equal height, but slender, and denuded of side branches. The white pines of this plantation are from trees from

seedlings gathered from American forests in 1866, planted 12 feet apart. They are 6 to 10 feet high in 1876. They are filled with Scotch pine for nurses, with trees grown from seed gathered from trees imported and planted in 1858. They were cultivated till able to protect themselves.

Scotch Pine, in close plantations, 4 to 6 feet apart, have a height of 20 to 25 feet, and a diameter of 6 to 7 inches. When standing separate they have twice this diameter, and form a beautiful tree, valuable as a wind-break, and growing surely and rapidly on nearly every variety of soil. They are very hardy.

Black Austrian Pine grows equally well with the Scotch, and mainly valuable for ornament and wind-breaks.

Norway Spruce, when planted alone, spreads nearly as wide as it grows in height, forming a beautiful pyramid. The greatest diameter of the trunk of these trees is 15 inches, from trees planted in 1857, one foot in height.

American White Spruce.—This is a beautiful tree, equally, if not excelling the Norway, and with the same habits.

American Arbor-vitæ (white cedar).—This forms a beautiful tree when young and standing alone, and it may be successfully sheared to any desirable form. It grows slowly, and when planted closely in rows, 6 feet apart, and only one foot in the row, has a diameter of 2 to 4 inches, and 16 feet in height.

Siberian Arbor-vitæ is equally hardy with the American, and grows more compact and beautiful.

Hemlock, when planted on prairie soil, makes a slow and dwarfish growth, till twelve or fifteen years old. It is better on hard soil.

American Silver Fir (Balsam).—A rapid, beautiful grower, its main value being as an ornamental tree; is less hardy in the extremes of cold following exceedingly severe droughts, as in 1864-'65; as in case of the great droughts which then visited this Western country, when a great many of the finest of the balsam trees, many of them 40 feet in height, died.

European silver fir.—This is too tender for this climate, and has only flourished in protected situations. It has a height of 30 feet, and a diameter of 6 to 7 inches, and should be used only as an ornamental tree. Yet this tree shows early old age, and is less beautiful in twenty or thirty years.

Experience of tree culture in Illinois.

Mr. Samuel Edwards, of Mendota, Ill., reporting from a committee of the State Horticultural Society, in 1876,[1] speaks of the condition and prospects of tree-planting, and of the success and failure that has attended the experiments hitherto tried:

For several years the locust used to be *the* timber tree, and was quite extensively planted; and when the beautiful groves, on which so many had placed their dependence for future fencing, were destroyed by the borer, a general depression came over the minds of tree-planters. For a time their energies for work in this direction were paralyzed, and it is only recently, from observation of the growth and value of a few other varieties of trees as yet successfully cultivated here, confidence in timber-growing is being restored. Many have made small beginnings; a few are planting extensively of black walnut, European larch, ash of different varieties, white and Scotch pines, white willow, silver maple and ash-leaved maple; all of which give satisfaction except the silver maple, which is in some cases troubled with a borer, and limbs are broken in severe storms.

Some have advocated extensive planting of the chestnut, and for over twenty years they were thrifty on a prairie mound, clay soil, with good, natural under-drainage in my grounds. A severe winter succeeding a drought fatally injured one of the two trees set in 1851, and on my new grounds at Mendota, only some 4 feet to a stiff clay, they are very unsatisfactory; many trees 4 to 6 feet high were killed in the winter of 1874-'75. The tulip tree for twenty-five years from first planting grew finely. Quite a number on the grounds of Arthur Bryant and Tracy Reeve, at Princeton, and at "The Evergreens," Lamoille, failed under the same circumstances as the chestnut. The English walnuts grown at La Porte, Ind., were brought to one of the meetings of this society a few years since by W. H. Ragan, with the report that it proved hardy and had borne fruit there several years. I tried a second hundred from an Eastern nursery; they have all winter killed. Doubtless all of these varieties planted on timber soil in the southern and central parts of the State will succeed. It is evident, from past experience, that it will require several years to test varieties of trees before planting extensively on the prairies of our section of country.

A good beginning is being made in planting trees along the public highways, for

[1] *Transactions of Illinois Horticultural Society*, 1876, p. 115.

which white elm, ash, and silver maple are generally used. It is to be regretted that some continue to plant the Lombardy poplar, which is very short lived, and timber of so little value. Centennial trees were very generally set by our people who plant at all.

Several cemeteries, a number of farms in this vicinity, and the Blackstone Public School grounds in Mendota, have been improved the present year by planting extensive evergreen screens.

How any one can reside on our bleak prairies during the passage of one of our polar waves, like that of December 9, with the mercury at —23° and not decide to provide timber shelter for his family and animals, is past my comprehension. Yet how many men, with good sense in every other respects and with ample means, continue to live without this merciful provision! It really does seem certain that, at no distant day, a general awakening to this work of necessity, must break out all over the prairies of the Northwest.

Of ornamental deciduous trees, as yet planted only to a limited extent, I would place first on the list our lovely sugar maple. If there is a finer avenue of deciduous trees in our State than the one of sugar maple planted by Arthur Bryant, some forty years since, it has not been my good fortune to see it. Norway maple is one of the best, valuable on account of retaining its foliage late; cut-leaved weeping birch, very fine; weeping mountain ash; horse chestnut, slow grower, desirable; Japan ginko, unique; American linden, if foreign, would be called for; magnolia acuminata, unsurpassed. The following do not endure severe winters: European ash and several weeping varieties of it; European weeping linden; weeping thorn, several varieties; rosemary-leafed weeping willow. Kilmarnock weeping willow, though hardier than the foregoing, is frequently injured enough to render it undesirable.

Dr. J. T. Stewart, of Peoria, Ill., in reporting on arboriculture at the same session of the Illinois Horticultural Society, after noticing that whatever tends to cultivate and refine the taste of a people elevates them, and that this taste has too generally been neglected in matters of ornamental cultivation, although beginning to appear in a higher order of architecture in dwellings, proceeds to specify some of the trees and shrubs susceptible of fine cultivation in Middle Illinois. He states as a general rule that the indigenous trees of the State are more reliable than foreign ones, and that their preference of soil and conditions can generally be known beforehand by observing them in their native growth. Among the native trees of Middle Illinois he names the sugar and silver-leaf maples, box-elder, hackberry, linn, ash (five species), coffee-nut, wild black cherry, persimmon, pecan, honey-locust, sycamore, black walnut, red cedar, and, in Southern Illinois, the tulip tree, as of known and tried value. Of those not indigenous he recommends the European elm and linn, the Norway maple, birch, hemlock, larch, Norway and Scotch pine, mountain ash, catalpa, white willow, horse-chestnut, and Norway spruce.

Of the indigenous shrubs of Middle Illinois that are worthy of cultivation for ornament, he calls attention to the shad-bush, red-bud, wahoo, sumac, aromatic sumac, black and red haw, bladder-nut, red osier, dogwood, alternate-leafed cornus, and, in Southern Illinois, the flowering dogwood and Indian currant (*Symphoricarpus vulgaris*); of native vines, the Virginia creeper, trumpet creeper, wild grape, moonseed, virgin's bower, wild false-bittersweet (*Celastrus scandens*), and wild yam (*Dioscorea villosa*).

Distribution of forests in Illinois, based upon the census returns of 1870, dividing the State into the same districts as those adopted by the State Horticultural Society.

Districts.	Number of counties.	Area of district.		Acres of woodland.	Per cent. of woodland.
		Square miles.	Acres.		
1. *Fox River* (northeast corner)	12	7, 354	4, 706, 560	297, 353	6. 3
2. *Rock River* (northwest part)	11	6, 652	4, 257, 280	372, 720	8. 7
3. *Illinois River* (central part)	21	11, 280	7, 219, 200	1, 073, 593	15. 0
4. *Grand Prairie* (eastern-central part)	17	12, 096	7, 741, 440	513, 726	6. 6
5. *Centralia, or Wabash* (southeastern part, "Egypt")	17	7, 874	5, 039, 360	1, 216, 009	24. 0
6. *Alton or Kaskaskia* (southwestern part)	13	6, 970	4, 460, 800	964, 636	21. 6
7. *Grand Chain* (extreme southern part)	11	3, 646	2, 333, 440	623, 541	26. 6
Total	102	55, 872	35, 758, 080	5, 061, 578	14. 1

Although these statistics bear sufficient evidence of erroneous estimates, they at least prove a scarcity of timber, especially in the prairie region, far below the proper wants of the State, and show the need of tree culture on a much larger scale.[1]

MICHIGAN.

The lower peninsula of this State was originally, for the most part, heavily timbered, excepting a few small prairies and oak openings in the southern part. The clearing of the forests has been progressing quite rapidly within the last forty years, and already the effects are being noticed, as elsewhere more fully mentioned in connection with climate.

The State of Michigan owns, according to the report of 1876, 3,073,240 acres, of which 2,455,599 are swamp lands, and the remainder belong to certain funds, chiefly those of the agricultural college and the primary schools. The State appoints a trespass agent, and the net collections for 1875–'76 amounted to $19,186.91, being much more than in any previous year;—but, besides this, no measures have been taken to economize the timber resources owned by the State.

A State law has been in force about ten years, giving some encouragement to tree-planting upon the borders of highways, and more effectual

[1] The subject of timber supply and the distribution and want of woodlands in Illinois are considered in detail in a report made by Mr. W. C. Flagg, from a committee of the Illinois State Horticultural Society in 1872. He gives in this paper an alphabetical table of counties, showing area in square miles, acres of woodland, and number of acres of woodland per square mile. From this we arrange the counties in the order of greatest woodland, viz: Randolph, 281; Williamson, 269; Hardin, 254; Calhoun, 248; Edwards, 247; Pope, 242; Monroe, 219; Hamilton, 218; Gallatin, 211; Union, 210; Wayne, 204; Clark, 201; Lawrence, 199; Saline, 186; Crawford, 180; Scott, 178; Clay and Wabash, 172; Greene, 171; Jefferson, 165; Pike, 162; White, 156; Perry, 154; Jackson, 151; Schuyler, 147; Fulton and Jersey, 141; Richland, 140; Massac, 138; Adams, 136; Jasper, 132; Fayette, 130; Madison, 120; Brown, 119; Effingham, 116; Cumberland and Saint Clair, 115; Bond, 113; Menard, 111; Marion and Morgan, 107; Edgar, 106; Boone, 104; Jo Daviess and Putnam, 102; Clinton and Washington, 100; Shelby, 96; Macoupin, 94; McDonough, 91; Henderson, 90; Sangamon, 89; Cass, 88; Coles, 86; McHenry, 85; Mercer, 84; Peoria, 79; Alexander, 78; Stephenson, 76; Moultrie, 75; DeWitt and Marshall, 73; Tazewell, 72; Rock Island, 71; Winnebago, 69; Montgomery, 68; Carroll, 67; Kane, 64; Pulaski, 61; Kane and Ogle, 58; Mason, 57; Hancock, 56; Vermillion, 53; DuPage and Warren, 51; Bureau and Woodward, 48; Kendall and Lake, 44; Stark, 43; LaSalle, 42; McLean, 35; Macon and Whitesides, 31; Douglas, 29; Christian, Will, and Logan, 28; DeKalb, 26; Iroquois and Cook, 20; Lee, 17; Champagne, 16; Kankakee, 16; Henry, 15; Grundy and Piatt, 14; Livingston, 12; Ford, 6; Franklin and Johnson (?).

means have been urged, but without result.[1] The extraordinary development of the lumber trade of Michigan within the last twenty years gives great importance to this question, and we have endeavored to obtain as full and reliable information upon the subject as could be obtained. The laws for encouragement of tree-planting in this State are given on page 208 of this report.

Lumber Region of Michigan.

The pine region of Michigan has no distinct boundaries, being generally more or less mixed with deciduous kinds of timber.[2] It is mostly included between the Detroit and Milwaukee Railroad on the south and a line crossing the State from Alpina to Great Traverse Bay on the north. The southern and northern parts of the State were timbered chiefly with hard woods, and in the southern part were prairies of moderate extent and considerable tracts of "openings," or thinly timbered tracts, probably brought to this condition by annual running fires.

Saginaw Lumber District.

The Saginaw River is formed by the union of the Cass from the east, the Flint and Shiawassee from the south, and the Tittabawassee from the northwest, and from the confluence of these tributaries is about 25 miles in length.[3] Excepting an obstruction at Carrollton Bar, the Saginaw is navigable by vessels and steamers to Saginaw City, about 18 miles from the Bay, and at this point and below are located the lumber and salt manufactories, that have within the last 20 years given much prominence to this district.

---

[1] In a letter addressed by Gov. John A. Bagley to the citizens of Michigan, dated February 22, 1876, his Excellency strongly recommended tree-planting as a commemoration of the centennial year, and suggested the 15th day of April as proper for this occasion. Although this measure was more particularly designed as a patriotic commemoration of a great event in our national history, the language of the address implied a full appreciation of the great public importance of tree-planting by every owner of land and an earnest desire for its general practice.

[2] The Catalogue of Products of Michigan in the Centennial Exhibition contains the record of many trees of exceptionally large size. In a lot of pine containing 85 logs, the amount scaled was 107,455 feet, or an average of 1,264 feet, and the largest 2,025 feet. Several scaled 1,700 feet and over, and 200 logs averaged 900 feet each. They were mostly "cork-pine," a variety of the *Pinus strobus*, growing with hard timber on dry but rich soil, and with a very soft, nice wood.

A black walnut is mentioned as sold for $1,000, and another at $1,200. The owner of a "blister" walnut refused an offer of $2,000. Among these products at the exhibition was a specimen of natural grafting that attracted much attention. It consisted of two beech trees that grew in Oakland County, united by a branch at twenty-five feet above the ground.

[3] *Cass River* is about 125 miles long, and drains the counties of Saginaw, Genesee, Tuscola, Huron, and Sanilac.

Flint River, 103 miles; drains the counties of Oakland, Lapeer, Genesee, and Saginaw.

Shiawassee River, 95 miles; drains the counties of Livingston, Genesee, Shiawassee, and Saginaw.

Bad River, 54 miles; drains the counties of Gratiot and Saginaw.

Tittabawassee River, 117 miles; drains the counties of Midland, Gladwin, Ogemaw, Roscommon, Saginaw, and Clare.

Chippewa River, 90 miles; drains the counties of Isabella, Mecosta, Osceola, Clare, and Midland.

Pine River, 120 miles; drains the counties of Midland, Gratiot, Montcalm, Isabella, and Mecosta.

Salt River, 50 miles; drains the counties of Midland and Isabella.

Tobacco River, 37 miles; drains the counties of Clare, Gladwin, Midland, and Isabella.

Cedar River, 48 miles; drains the counties of Gladwin and Clare.

Total 864 miles available for floating and draining an area of about 3,500,000 acres.

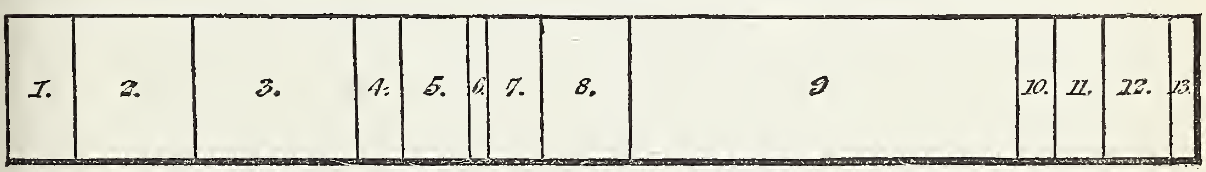
Capacity for lumber manufacture in the Saginaw Valley.[1]

Places.	Establishments.		Men employed.		Capacity for lumber manufacture (day sawing).	
	1876.	1877.	1876.	1877.	1876.	1877.
Saint Charles and Saginaw County Mills	......	......	160	178	45,000,000	57,000,000
Saginaw City	6	6	305	329	78,000,000	65,000,000
East Saginaw	14	15	491	444	111,500,000	108,000,000
Florence	5	5	178	156	32,000,000	38,500,000
Carrollton	5	5	175	154	43,000,000	35,000,000
Crow Island	1	1	35	......	10,000,000	10,000,000
Zilwaukee	3	3	140	115	38,000,000	38,000,000
Melbourne	1	1	80	80	20,000,000	20,000,000
Williamstown	......	1	......	22	......	5,000,000
Frankenlust	......	1	......	6	......	2,000,000
Stone Island	......	1	......	25	......	6,000,000
Bay City	26	24	1,353	1,318	309,500,000	305,500,000
Salzburg	3	......	118	......	26,000,000	......
Menona	2	......	155	......	30,500,000	......
Banks	3	......	215	......	47,000,000	......
West Bay City	......	8	......	597	......	112,500,000
Kawkawlin	1	......	75	......	20,000,000	20,000,000
Total	70	71	3,480	3,424	810,500,000	822,500,000

[1] This table is prepared from statistics published in the *Lumberman's Gazette*, at Bay City.

Comparative productions of lumber in the Saginaw Valley in 1876.

For convenience of illustration, we have prepared the following diagram, in which, assuming the total production of the Saginaw Valley in 1876 to be represented by the total length of the figure, the proportional quantity manufactured at each place would correspond with the relative area of the several compartments as numbered:



1. Saint Charles and Saginaw County Mills.
2. Saginaw City.
3. East Saginaw.
4. Florence.
5. Carrollton.
6. Crow Island.
7. Zilwaukee.
8. Melbourne.
9. Bay City.
10. Salzburg.
11. Wenona.
12. Banks.
13. Kawkawlin.

Several of the establishments in the foregoing tables run two mills, and most of them have salt-works connected, by which they are able to economize the waste steam from the engines in the evaporation of brine, and to use the sawdust and slabs as fuel to great advantage. In fact nowhere can so little refuse material be seen around great lumbering establishments as here.[1]

[1] The existence of salt-bearing strata promising remuneration for investment, was first suggested by Dr. Douglas Houghton, from the geological features of the country and occasional salt-licks. From the earliest period the Indians were known to supply themselves from native springs. The report of Dr. Houghton, first made in 1838, was not followed by successful operations until about twenty years afterward. In 1859 the manufacture was begun at East Saginaw, and for a few years the business was encouraged by a State bounty. The production, however, increased so rapidly that it soon become evident that it needed no further aid from the State, and the production has already in a large degree supplanted that from the Onondaga salines of New

The first occupation of Saginaw began with a military post on the site of Saginaw City in 1822. The first lumber-mill was erected in 1836, and in 1853 there were 61 mills in the territory included within Saginaw, Bay, Shiawassee, and Genesee Counties, none being north of these. They had a capacity of about one hundred millions of feet a year, and 23 were located along the Saginaw River. There are now over 300 mills in the above territory, capable of cutting over a billion of feet a year.

The record from the Saginaw Valley proper, not including contiguous territory, has, since 1863, been as follows:

York, in the markets of the Northwest. The number of barrels made annually since 1860 has been as follows:

Years.	Barrels.	Years.	Barrels.	Years.	Barrels.	Years.	Barrels.
1860	4,000	1865	477,200	1870	646,516	1874	971,587
1861	125,000	1866	407,077	1871	735,015	1875	970,444
1862	243,000	1867	474,721	1872	715,316	1876	1,148,253
1863	466,356	1868	555,690	1873	810,495	1877	1,381,341
1864	529,073	1869	596,873				

The business at the close of 1877 was divided among 76 manufacturers, of which 10 were on "the shore," from Port Austin to Oscoda, 27 in Bay County, and 39 in Saginaw County. The number of kettle-blocks was 20; of steam-blocks, 71; of pan-blocks, 22, and of salt-covers, 3,800. Capacity, 2,100,000 barrels, and amount manufactured in 1877, according to inspector's report, 1,660,897 barrels. The qualities for the year 1877 were: fine, 1,590,841; packers', 20,858; solar, 22,949, and second quality, 26,249. The quantity made in kettles was 182,560 barrels; in pans, 371,642; by steam, 1,083,646, and by solar evaporation 22,046. There was a large decrease in the amount made by the kettle or boiling process, and a large increase of that by steam. In 1875 there were 95 salt-blocks, 240 grainers, 1,310 kettles, 55 pans, 4,092 covers, and 119 wells, varying from 700 to 1,760 feet. With two exceptions, they were less than 1,200 feet, and averaged 800 to 900 feet. As to mode of manufacture, 35 used steam in evaporating the brines, 11 used pans, 8 kettles, 9 steam and pans, 4 steam and kettles, 3 kettles and solar heat, 1 kettles and pans, and 1 solar heat and steam. The fuel used in kettle-blocks is cord-wood mixed soft and hard, refuse slabs, and sawdust; and one block will use 10 cords of mixed wood or 16 cords of slabs in 24 hours. Pan-blocks on the Saginaw are run almost entirely on slabs and sawdust, but on the lake shore cord-wood is used. A pan-block 90 feet long and 16 feet wide, will use 13 cords of mixed wood in 24 hours, making 140 barrels of salt. Steam-blocks are mostly heated by day with the exhaust steam, which is carried through the settlers and graining vats, heating them to a degree less than boiling. If the mill does not run nights, the steam-pipes are connected with the mill-boilers and live steam is kept up through the night, the fuel being sawdust, &c. In some instances the salt-works are run several weeks longer than the mill. The barrels are mostly of pine, from refuse lumber and slabs, but in some mills elm is made into staves and heading for this use. The usual investment for a salt manufactory is about $20,000, which may be stated in detail as follows: Engine and boiler for two wells, $2,800; drilling salt-wells, $2,200; poles for wells, $250; tubing, $1,400; pump chamber and valves, $250; salt-block, cisterns, settlers, and grainers, $9,600; tubing and connection to salt-block, $3,500.

The salines of Saginaw and the shore belong to private owners; but the State maintains a supervision by way of inspection, for the purpose of preventing deterioration of quality and for securing statistical record. An inspector is appointed by the governor and senate. He is aided by deputies and receives a fee for services. There are ten inspection districts. (See *Report on the Salt Manufactures of Michigan*, prepared for Geological Report by S. S. Garrigues, Ph. D., and *Lumberman's Gazette*, December 29, 1877, for further details.)

The geological formation of this region favors the sinking of wells throughout a wide area in the valleys of the Grand and Tittibawassee Rivers and elsewhere, usually to depths of about 800 feet, but ranging from 560 to 1,100. The brine does not flow from these wells, but must be pumped from 100 to 200 feet, and the capacity of the wells varies from 12 to 20 gallons per minute. The collateral products of these brines are beginning to have a value in the manufacture of artificial stone, calcined magnesia, and the bromide of magnesium. The refuse salt has also a value as a manure, and should be more generally used.

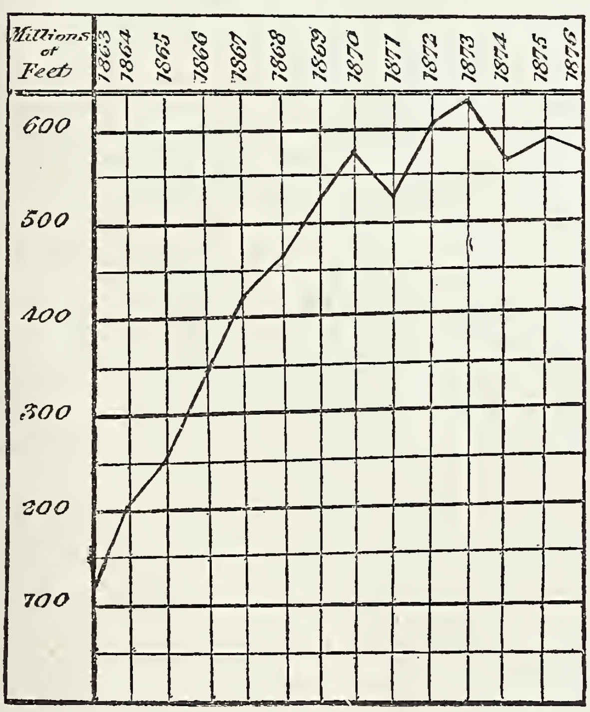
Lumber.

Years.	Feet.	Change from previous year.	Years.	Feet.	Change from previous year.
1863	133, 500, 000	....	1871	529, 682, 878	−47, 043, 728
1864	215, 000, 000	+81, 500, 000	1872	602, 118, 980	+72, 436, 102
1865	250, 639, 340	+35, 639, 340	1873	619, 867, 021	+17, 748, 041
1866	349, 767, 884	+99, 128, 544	1874	574, 632, 771	−45, 234, 250
1867	423, 963, 190	+74, 195, 306	1875	581, 558, 273	+ 6, 925, 502
1868	457, 396, 225	+33, 433, 035	1876	573, 050, 771	− 8, 057, 502
1869	523, 500, 830	+66, 104, 605	1877	640, 166, 231	+67, 115, 460
1870	576, 726, 606	+53, 225, 776			

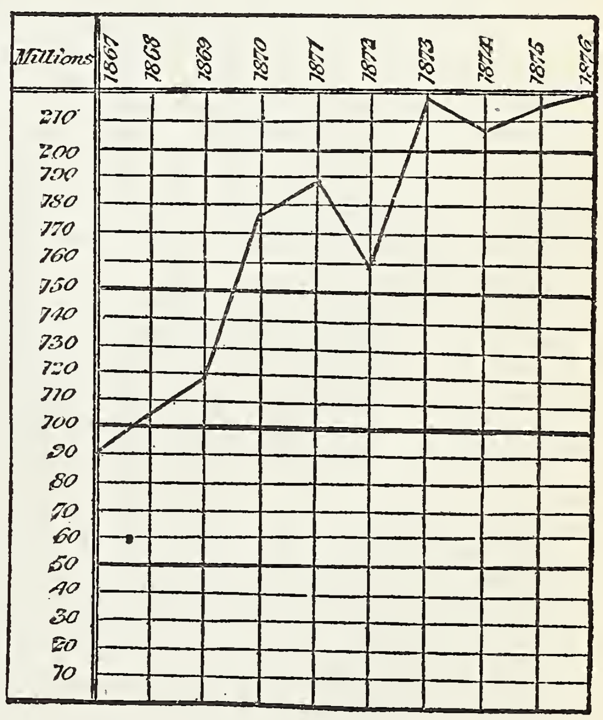
Shingles.

Years.	Number.	Change from previous year.	Years.	Number.	Change from previous year.
1867	90, 983, 000	....	1872	159, 001, 750	−28, 689, 250
1868	104, 104, 500	+13, 121, 500	1873	218, 394, 550	+59, 392, 800
1869	119, 843, 500	+15, 739, 000	1874	208, 489, 500	− 9, 805, 050
1870	178, 570, 000	+58, 726, 500	1875	212, 934, 250	+ 4, 444, 750
1871	187, 691, 000	+ 9, 121, 000	1876	218, 678, 750	+ 5, 744, 500

The comparative quantities in the above table are represented in the following diagrams:



Total production of lumber in Saginaw Valley since 186



Shingles manufactured in the Saginaw Valley since 1863.

Amount of lumber passed by the Tittabawassee Boom Company, Saginaw, Mich., since 1864.

Year.	Logs.	Feet (board-measure).	Price per M feet.[1]	Average feet per log.
1864	437, 236	106, 356, 789	$0 66	243. 2
1865	595, 806	148, 656, 072	1 00	249. 5
1866	753, 878	185, 381, 653	87½	245. 9
1867	945, 416	229, 330, 215	87½	242. 5
1868	985, 442	228, 871, 300	80	232. 2
1869	1, 272, 346	276, 660, 796	80	217. 4
1870	1, 510, 976	346, 524, 198	75	229. 3
1871	1, 259, 945	288, 748, 401	70	229. 1
1872	1, 559, 908	309, 151, 609	81	198. 1
1873	1, 413, 010	268, 959, 149	88	190. 3
1874	1, 978, 976	338, 203, 124	78	170. 9
1875	1, 860, 165	309, 808, 517	75	166. 0
1876	1, 972, 814	342, 981, 639	75	173. 8
1877	2, 352, 441	422, 896, 509	63	179. 8
Total	18, 898, 359	3, 802, 529, 971	....	204. 1

[1] From 1872 to 1877 this price includes furnishing the rope.

This company was organized February 8, 1864, under the general law approved four days previously, for the formation of corporations for running, booming, and rafting logs.[1] It is a short distance above Saginaw City, its business extending to the Saginaw, Tittibawassee, Chippewa, and Pine Rivers.

A noticeable feature of the above statistics is the decreasing average size of the logs rafted, the average of the later years being considerably less than the earlier.[2]

Amount of lumber passed by the Rifle River Boom Company since 1867, *in feet.*

1867	23,911,547	1871	55,823,013	1875	92,128,200
1868	48,044,946	1872	61,000,000	1876	61,000,000
1869	55,349,981	1873	80,872,607	1877	70,274,295
1870	80,427,714	1874	58,687,083	Total	687,519,386

*Feet of logs rafted in the Saginaw district during the last eight years.**

Years.	Tittabawassee.†	Cass.	Bad.	Rifle.	Au Gres.‡	Kawkawlin.	Au Sable.
1870	347, 041, 250	60, 942, 233	14, 894, 521	80, 427, 714	35, 091, 635	25, 000, 000	60, 000, 000
1871	288, 748, 401	55, 841, 618	14, 258, 818	55, 823, 013	31, 125, 084	24, 000, 000	52, 000, 000
1872	310, 216, 000	99, 113, 915	18, 284, 621	61, 000, 000	23, 870, 742	27, 000, 000	105, 000, 000
1873	269, 508, 740	100, 458, 140	37, 137, 384	80, 872, 607	63, 281, 236	33, 573, 354	96, 148, 000
1874	343, 814, 365	40, 000, 268	26, 000, 000	58, 687, 083	38, 723, 688	22, 000, 000	52, 000, 000
1875	309, 908, 517	56, 003, 470	41, 854, 894	92, 128, 200	10, 948, 620	19, 000, 000	55, 000, 000
1876	341, 000, 000	18, 000, 000	36, 000, 000	61, 000, 000	49, 229, 472	22, 500, 000	47, 150, 000
1877	422, 500, 000	22, 029, 160	28, 000, 000	70, 274, 295	32, 645, 493	15, 319, 000	60, 800, 000
Total	2, 632, 737, 273	452, 388, 804	216, 430, 238	560, 212, 912	284, 915, 970	188, 392, 354	528, 098, 000

* This table includes the Au Sable, which flows into Saginaw Bay, but is not a tributary of the Saginaw River. The mills on this stream are mostly at Oscoda and Au Sable. Some logs are towed to Detroit and a few to Saginaw. The quantities in the above table are arranged from data given in the *Northwestern Lumberman* of December 29, 1877.

† It will be seen, on comparison, that the numbers in this column differ somewhat from those given elsewhere from the books of the company. It is probable that in the haste to present the results of the year, statistics may have been taken on estimates made in some cases before the end of the season.

‡ The following amounts show the number of feet run out of this boom during three years preceding those included in the table, and carry back its transactions to the beginning: 1867, 17,980,000; 1868, 18,800,000; 1869, 22,296,611. The total for eleven years amounted to 373,992,581 feet. It is estimated that forty millions of feet had been ran out of this stream before the establishment of the boom company in 1867.

[1] This law is singularly defective in not affording the means for an annual report of doings to a central office, nor even the knowledge of the existence of the companies in any office at the State capital. The articles of association are simply filed with the county clerk of the county where located, and no public reports are required. Such companies have also been formed for the Cass, Flint, Bad, Pine, Au Sable, and other rivers, and at Alpena, Grand Rapids, Muskegon, Big Rapids, Manistee, &c., and are, in fact, indispensable where several firms or establishments exist on any stream.

[2] As an indication as to the relative abundance of timber suitable for lumber elsewhere, it is mentioned by a prominent lumberman in Wisconsin using logs from the Wolf River region that ten years ago it required, on an average, 3½ to 4 logs for 1,000 feet of lumber. This quantity will now, according to his experience, require 5 logs. The minimum size he then used was 12 inches in diameter; it is now 10 inches.

Total for eleven years.[1]

1867	429,507,000	1874	581,225,404
1868	446,960,000	1875	584,843,701
1869	521,350,000	1876	574,879,472
1870	623,397,353	1877	651,567,948
1871	521,796,934		
1872	644,485,278	Total	5,860,992,551
1873	280,979,461		

Destination of shipments from Saginaw River in 1875, 1876, *and* 1877.

[From Lumberman's Gazette, xi, 402.]

Ports.	Lumber.			Shingles.		
	1875.	1876.	1877.	1875.	1876.	1877.
Ashtabula	1,657,974	698,000	....	1,495,000	2,332,000	4,113,000
Black River	1,863,373	1,790,000	2,263,000	....	....	1,600,000
Buffalo	75,446,835	76,938,655	95,673,593	26,144,000	18,288,000	25,073,000
Chicago	32,759,895	11,802,569	11,629,784	....	....	908,000
Cleveland	87,433,708	76,956,761	95,552,845	57,860,000	55,255,000	83,293,000
Detroit	4,796,760	4,900,134	13,323,112	....	....	....
Dunkirk	4,447,041	6,841,354	5,447,000	3,431,500	2,620,000	3,782,000
Erie	10,009,510	11,380,000	16,628,000	2,830,000	1,170,000	7,808,000
Fairport	922,480	740,000	1,939,467	....	....	1,254,000
Fremont	752,422	1,087,007	906,000	....	....	300,000
Milwaukee	....	865,000	480,000	....	....	....
Oak Orchard	219,143	201,000	....	....	....	....
Ogdensburgh	7,963,000	12,920,000	6,177,500	....	....	....
Oswego	4,005,414	2,669,197	2,280,768	....	....	....
Port Clinton	....	....	2,050,000	....	84,000	200,000
Port Huron	....	981,000	....	....	....	....
Sandusky	23,246,621	21,150,855	20,945,000	5,270,000	1,886,000	5,341,000
Toledo	74,480,046	85,870,621	103,200,442	6,763,000	9,300,900	8,989,000
Tonawanda	112,333,616	134,620,468	155,627,193	13,699,000	13,107,150	16,065,250
Wallaceburg	213,000	246,469	....	....	....	....
Miscellaneous	2,568,757	2,687,639	5,739,343	340,000	1,700,000	3,868,000
Total	445,119,595	455,346,669	539,863,047	117,832,500	105,743,050	162,594,250

Shipments of lath from Saginaw River in 1875, 1876, *and* 1877.

[From Lumberman's Gazette, xi, 104.]

Ports.	1875.	1876.	1877.
Ashtabula	990,000	300,000	665,000
Black River	721,000	520,000	1,300,000
Buffalo	4,450,500	3,079,000	4,602,200
Cleveland	16,937,800	11,519,250	12,539,000
Dunkirk	....	450,000	500,000
Erie	1,870,000	1,454,000	883,000
Fairport	128,000	330,000	562,000
Fremont	288,000	100,000	
Port Clinton	....	160,000	....
Sandusky	3,098,600	2,151,650	2,036,000
Tonawanda	4,845,200	2,450,000	3,709,450
Toledo	8,166,600	7,229,850	11,894,803
Miscellaneous	1,017,000	260,000	1,362,000
Total	42,512,700	30,003,750	40,053,453

[1] It is not easy to comprehend quantities so vast as these aggregates. The total sum for the eleven years would lay a floor over 210 square miles (equal to nearly 6 townships of government surveys), or in a beam one foot square would extend nearly 92,500 miles, a distance that would measure 3.7 times around the earth at the equator. If spread out into one-inch boards, it would gird the earth with a floor nearly 44 feet in width, or would lay a floor 4.6 feet wide a distance equal to that from the earth to the moon. It would build 16 solid pyramids, each 500 feet square at the base and with equilateral sides or, if cut and piled as cord-wood, would make 3,816,531 cords, which, at 4 feet high and 4 feet wide, would extend 5,780 miles in length.

In another part of this report we present a general summary of the lumber product of the Northwestern States for 1874, 1875, and 1876, and to some extent for 1877, and to this the reader is referred for further statistics of Michigan.

The oak and stave trade of Saginaw.

In recent years the exportation of staves and square timber has assumed great importance. It was begun about 1869 by Canadian operators, who have chiefly monopolized the business. The greater part of the staves and timber finds its way to Europe and the West Indies by way of Quebec. The amount shipped in each year from the Saginaw River has been as follows:

	Cubic feet.		Cubic feet.
1869	765,000	1874	2,893,700
1870	1,105,000	1875	1,234,000
1871	1,982,000	1876	1,178,145
1872	2,560,000	1877	1,344,000
1873	3,264,920		
Total			16,326,765

The shipments in 1874 and 1875, in cubic feet, were as follows:

	1874.	1875.		1874.	1875.
Kingston	1,171,000	689,000	Clayton	137,000	159,000
Garden Island	28,800	....	Tonawanda	438,300	117,500
Collins Bay	54,000	111,500	Buffalo	....	35,000
Port Dalhousie	....	26,000	Sandusky	....	87,000
Sarina	....	9,000	Cleveland	1,000,000	....
Total Canadian ports	1,253,800	835,500	Total American ports	1,575,300	398,500

As the shipments to Clayton all go down the Saint Lawrence, we have a total to Canada of 1,391,800 cubic feet in 1874, amounting to 49 per cent. of the whole, and in 1875, 994,500 cubic feet, or 71 per cent.

The oak and ship timber going to Kingston and other Canadian ports in 1877 amounted to 1,297,700, and to Tonawanda, for the New York canals, 47,300 cubic feet. In the winter of 1877–'78, much less oak was got out, but more attention was given to long timber, spars, and square pine.

The shipment of staves in three years has been—

To what place shipped.	1875.	1876.	1877.
Tonawanda	198,000	126,000	162,000
Buffalo	2,222,956	5,748,000	2,822,700
Cleveland	....	4,000	350,000
Detroit	....	....	800,000
Collins' Bay	81,100	178,004	48,400
Kingston, &c	485,065	285,205	637,759
Miscellaneous	126,600	300,000	150,000
Total	3,113,721	6,641,209	4,970,859

The foregoing amounts do not include the shipments by railroad, estimated at 1,000,000 in 1877, which was less than the amount represented by rail shipments the year before. The total may therefore be estimated at about 6,000,000.

Exportation of hoops from Saginaw River.

Hoops are of two classes, hard and soft wood, the former constituting he principal part. They are sent to eastern ports, and are destined for New York, Philadelphia, and Eastern cities.

The quantity sent by water was as follows in 1877:

Tonawanda	1,203,000	Oswego	1,400,000
Buffalo	1,267,000	Cleveland	290,000
Ogdensburg	470,000	Miscellaneous	1,000,000

Add 4,400,000 sent by railroad, and we have a total of over 10,000,000.

Total, 1874	25,630,000	Total, 1876	17,801,600
Total, 1875	15,940,400	Total, 1877	5,630,000

Stocks on hand.

This item is an important one in the lumber trade. The following, from the *Lumberman's Gazette* of December 22, 1877, gives the amount at Saginaw at the close of each season since 1865, in feet, board measure:

	On dock.	Sold.	Unsold.
1865	44,453,000	22,362,000	19,091,000
1866	44,415,700	14,211,000	30,204,700
1867	69,966,771	19,435,571	50,534,200
1868	67,401,017	13,402,990	53,968,027
1869	93,331,614	14,526,000	78,805,614
1870	130,422,190	47,862,000	82,560,190
1871	75,599,511	33,576,000	42,023,511
1872	152,822,553	40,928,200	111,894,353
1873	222,071,665	30,893,000	191,178,665
1874	213,152,663	23,135,000	190,017,663
1875	223,106,140	25,595,578	197,510,562
1876	224,546,657	26.136,664	168,409,993
1877	245,935,522	23,611,666	222,323,856

Wood manufactures at Saginaw.

The manufacture of boxes, pails, tubs, churns, &c., besides a great variety of articles saved from what was formerly regarded as refuse lumber, such as heading, pickets, and the like, form an important item, but we have no statistics of the amount. There is at present but little waste of material in the manufacture of lumber in this region.

A large amount of cedar posts, railroad ties, spars, knees, and other articles is exported from the Saginaw Valley, of which we have no details.

Estimated values.

The estimated values of lumber products of Saginaw, in 1877, were as follows:

Lumber, 640,000,000 feet	$6,400,000
Shingles, 167,338,750	417,845
Laths, 77,000,000 pieces	96,250
Staves, 6,000,000	260,000
Timber, 1,344,000 cubic feet	280,000

Adding other wood products, the yield for the year would be about $8,500,000.

Saw and shingle mill reports on the Lake Huron shore for the season of 1877.[1]

Places.	Establishments.	Saws. Gang.	Saws. Circular.	Saws. Muley.	Shingle-machines.	Number of men.	Lumber.	Laths.	Shingles.
Alpena	15	8	4	....	10	471	74, 247, 037	22, 742, 000	30, 493, 098
Harrisville	2	1	1	1	......	45	2, 500, 000	....	....
Alcona	1	....	1	....	......	30	3, 000, 000	1, 000, 000	....
Au Sable	2	2	2	1	......	74	13, 637, 234	1, 000, 000	....
Oscoda	3	3	4	1	......	135	26, 102, 796	500, 000	....
Total, 1877	23	14	12	3	10	755	119, 487, 067	25, 242, 000	30, 493, 098
Production of Alpena						1875	81, 158, 000	19, 933, 150	44, 906, 000
						1876	85, 346, 927	23, 542, 400	42, 616, 000
Production of Harrisville and Alcona						1875	6, 750, 000	1, 600, 000	....
						1876	3, 500, 000	1, 000, 000	....
Production of Au Sable and Oscoda						1875	47, 000, 000	4, 530, 000	....
						1876	54, 250, 000	5, 800, 000	....

[1] These returns for 1877 are not claimed as complete. The reduced amounts at Oscoda are due to the loss of two large mills by fire. One is being rebuilt, with two circulars- and a fifty-saw gang.

Comparative statement of lumber, laths, and shingles manufactured on the Lake Michigan shore in 1875, 1876, *and* 1877.

[From the Lumberman's Gazette, December 29, 1877.]

LUMBER.

Places.	1875.	1876.	1877.
	Feet.	*Feet.*	*Feet.*
Grand Rapids	39, 200, 000	39, 575, 047	38, 353, 000
Grand Haven, &c	91, 500, 000	58, 700, 000	86, 200, 000
Muskegon	303, 010, 225	290, 363, 585	320, 572, 467
Whitehall	29, 500, 000	36, 000, 000	30, 883, 511
Montague	45, 000, 000	44, 000, 000	49, 750, 657
Mears, &c	....	....	7, 800, 000
Pentwater	15, 500, 000	10, 500, 000	8, 000, 000
Ludington, &c	95, 044, 212	100, 346, 930	106, 732, 420
Manistee	150, 500, 000	145, 750, 000	151, 184, 104
Traverse City	15, 000, 000	13, 500, 000	15, 000, 000
South Haven	6, 780, 000	3, 500, 000	3, 000, 000
Holland	....	....	1, 500, 000
Northport	75, 000	240, 000	200, 000
Total	791, 109, 437	742, 475, 562	819, 176, 159

LATHS.

Places.	1875.	1876.	1877.
	M.	*M.*	*M.*
Grand Rapids	10, 000, 000	7, 800, 000	9, 850 000
Grand Haven, &c	5, 500, 000	6, 850, 000	17, 600, 000
Muskegon	80, 058, 400	65, 737, 400	82, 277, 050
Whitehall	8, 500, 000	11, 000, 000	4, 000, 000
Montague	2, 000, 000	1, 500, 000	8, 500, 000
Pentwater	2, 000, 000	1, 000, 000	3, 000, 000
Ludington, &c	5, 430, 100	3, 552, 400	2, 043, 000
Manistee	30, 000, 000	27, 500, 000	26, 800, 000
Traverse City	4, 000, 000	3, 000, 000	....
South Haven	....	....	500, 000
Total	147, 488, 500	127, 939, 800	154, 570, 050

SHINGLES.

Places.	1875.	1876.	1877.
	M.	*M.*	*M.*
Grand Haven, &c	40, 000, 000	45, 000, 000	66, 000, 000
Muskegon	6, 000, 000	10, 000, 000	15, 000, 000
Whitehall	12, 000, 000	13, 000, 000	46, 403, 000
Montague	12, 000, 000	13, 000, 000	17, 000, 000
Mears, &c	....	....	8, 500, 000
Pentwater	....	....	21, 000, 000
Ludington, &c	4, 000, 000	8, 000, 000	20, 644, 000
Manistee	148, 500, 000	181, 091, 000	219, 208, 250
Total	222, 500, 000	270, 091, 000	413, 755, 250

Comparative statement of the lumber product of Western Michigan in 1875, 1876, *and* 1877.

[From the North-Western Lumberman, February 16, 1878.]

Places.	No. of establishments.	Saws.				Season capacity, day-sawing.	Lumber manufactured.		
		Gang.	Circular.	Muley.	Gang-edger.		1875.	1876.	1877.
Manistee	14	1	26	....	24	197, 000, 000	160, 825, 855	146, 424, 206	148, 983, 152
Ludington	6	2	12	....	12	123, 000, 000	94, 800, 000	104, 724, 917	105, 328, 873
White Hall and Montague	11	2	14	4	15	101, 000, 000	64, 000, 000	79, 600, 000	82, 420, 000
Muskegon	24	10	37	7	46	381, 000, 000	330, 400, 000	396, 334, 000	327, 325, 106
Spring Lake and Grand Haven	13	1	17	3	18	110, 500, 000	83, 100, 000	58, 500, 000	80, 805, 871
Miscellaneous	17	2	19	3	17	111, 000, 000	84, 080, 000	74, 360, 000	72, 322, 946
Total	85	18	125	17	132	1, 023, 500, 000	817, 205, 855	859, 943, 123	817, 185, 948

Michigan West Side Railroad Mills; cut of lumber, laths, and shingles in the year 1877.

[From the Lumberman's Gazette, January 19, 1878.]

Places.	No. of establishments.	Saws.			Shingle-machines.	No. of men.	Lumber.	Laths.	Shingles.
		Gang.	Circular.	Muley.					
GRAND RAPIDS AND INDIANA RAILROAD.									
Cedar Springs	12	....	1	2	12	151	4, 800, 000	....	66, 500, 000
Sand Lake	8	....	6	1	8	176	9, 553, 000	500, 000	48, 500, 000
Lockwood	7	....	2	1	10	82	10, 000, 000	....	60, 000, 000
Cadillac	6	....	1	1	3	71	28, 262, 130	....	7, 500, 000
Big Rapids	5	2	3	2	4	270	18, 000, 000	6, 000, 000	15, 500, 000
Morley	3	....	1	....	5	15	....	....	16, 900, 000
Howard City	2	....	1	....	11	185	....	....	38, 000, 000
Pierson	1	....	1	....	1	20	2, 000, 000	....	7, 000, 000
Bond's Mills	1	....	1	....	....	20	250, 000	....	....
Wood Lake	1	....	1	....	....	30	2, 000, 000	1, 000, 000	....
Manton	1	....	1	....	....	20	3, 000, 000	....	....
White Lake	1	....	1	....	....	15	2, 000, 000	....	....
Tustin	1	....	1	....	....	15	2, 500, 000	....	....
Leroy	2	....	2	....	....	48	6, 500, 000	2, 000, 000	....
Total	51	2	23	7	54	1, 118	88, 865, 130	9, 500, 000	259, 900, 000
DETROIT, LANSING AND NORTHERN RAILROAD.									
Stanton	18	....	9	....	14	285	25, 900, 000	1, 800, 000	77, 000, 000
Day and Stanton	17	....	5	....	17	216	10, 750, 000	1, 000, 000	71, 000, 000
Muir and Sheridan	6	2	4	....	4	170	21, 000, 000	5, 000, 000	25, 000, 000
Ionia and Sheridan	1	1	1	....	....	23	6, 157, 639	2, 800, 000	....
Colby	1	1	1	....	1	20	5, 000, 000	....	7, 000, 000
Greenville	7	....	2	....	9	113	8, 000, 000	1, 000, 000	40, 800, 000
Trufant	2	....	2	....	2	105	11, 739, 922	4, 601, 750	7, 200, 000
Maple Valley	2	....	3	....	....	55	11, 000, 000	....	....
Gowen	1	....	1	....	1	12	1, 000, 000	....	6, 000, 000
Coral	1	....	1	....	....	40	4, 000, 000	1, 500, 000	....
Colwell	1	....	1	....	....	40	5, 000, 000	2, 000, 000	....
Total	57	4	30	....	48	1, 079	109, 547, 561	19, 701, 750	234, 000, 000
CHICAGO AND LAKE MICHIGAN RAILROAD									
Fremont Center	5	....	3	4	2	40	4, 500, 000	200, 000	4, 600, 000
Dalton	2	....	2	1	....	75	10, 000, 000	....	5, 000, 000
White Cloud	1	....	2	....	....	50	5, 000, 000	1, 000, 000	....
Traverse Road	1	....	1	....	....	15	500, 000	....	....
Total	9	....	8	5	2	180	20, 000, 000	1, 200, 000	9, 600, 000
General total	117	6	61	12	104	2, 377	218, 412, 691	30, 401, 750	503, 500, 000

Lumber traffic on three west-side railroads of Michigan in 1877. (Car loads.)

Railroads.	Pine.	Shingles.	Hard wood.	Laths.	Total.
Cincinnati, Richmond and Fort Wayne Railroad	317	71	1,370	14	1,772
Grand Rapids and Indiana Railroad	11,830	6,758	1,162	285	20,035
Traverse City Railroad	116	43	224	......	383

A general review of the lumber resources of Michigan.

In an article prepared by George S. Frost, and published in the "*Compiled Statement of the Lumber Trade and Manufacture for* 1874" (p. 41,) the following account is given of the pine lands of this region:

1. *The Saginaw district or valley* embraces the counties of Tuscola, Lapeer, Saginaw, Gratiot, Isabella, Gladwin, Clare, and Midland, and is drained by the following streams, all tributaries to the Saginaw River: the Flint, Cass, Pine, Chippewa, Tobacco, and Tittibawassee. Of these streams the Flint and Cass have been extensively lumbered, and are now practically exhausted. The pine of these streams is of superior quality, not surpassed by any other district of the State. The Chippewa and Pine have also been largely lumbered, and the principal timber of these streams now lies upon the headwaters. There is a ridge of superior timber running northeast from the headwaters of Flat River, in Montcalm County, and covering the headwaters of the Pine, the Chippewa, the Tobacco, the Tittabawassee, and continuing across to the headwaters of Au Sable, and into Montmorency County, and along the headwaters of Thunder Bay River, and the Cheboygan and Manistee waters. This is substantially the dividing ridge of the peninsula, and the pine along its course belongs and is tributary to nearly all the principal streams of Lakes Huron and Michigan. Each district which will be described embraces more or less of this timbered ridge. The Saginaw Valley is crossed by several lines of railway: the Flint and Pere Marquette, the Detroit and Bay City, the Jackson, Lansing and Saginaw and the Saginaw, and Saint Louis Railroads. The Flint and Pere Marquette Railroad, commencing at Flint, passes through a small lumber district between Flint and Saginaw; from thence this road passes through the very heart of the timber regions of the Saginaw, Muskegon, and Pere Marquette Valleys. The important lumber center of the Saginaw receives the logs as well as the lumber from the Saginaw waters, yet the railroads mentioned have induced new manufacturing centers at different points along their routes. Midland City, Farwell, and other stations between Saginaw and the Muskegon, crossing at Evart, and Reed City, Baldwin, and other stations on the west, are all centers of manufacture. The facilities thus afforded through an extensive pine-timber district have already brought the whole territory into notice, and the necessary operations, however small in detail, are *surely*, if not *rapidly*, diminishing the products of these forests.

2. *The Saginaw Bay district*, drained by the Pine, Rifle, and Au Gres Rivers, and other smaller streams and bordering the Saginaw Bay. It embraces the counties of Bay, Ogemaw, and Iosco, and is opened by the Jackson, Lansing and Saginaw Railroad. This has long been a lumber-region tributary to Saginaw, and the Rifle River particularly has been a source of supply of long timber for the lower lakes. The extent of lumbering in this district has drained from it a large proportion of the best timber, especially on the lower waters of the streams. The upper pine districts are opened by the railroad, and even along the bay shore the lumber interests are affected and to considerable extent transformed by the influence and advantages of the railroad.

3. *The River Au Sable.*—This river has a large manufacturing center at its mouth on Lake Huron, where a large trade is carried on. The counties of Alcona, Iosco, Oscoda, Crawford, Roscommon, Otsego, and Montmorency are drained in part by this stream, the main stream taking its rise in Montmorency and Otsego Counties, and the south branch in Roscommon County, there reaching and competing for the pine upon the headwaters of the Muskegon, the Manistee, and the Thunder Bay Rivers. The pine of this region is of excellent quality, embracing at different points along its waters the largest class of white pine, as well as the best qualities of Norway. As before intimated, this peninsula is so well watered that the different streams interlock each other so that in the same pine region the timber has a natural outlet in various directions; and what is said of the pine timber of the Au Sable is descriptive of that of the Manistee, the Muskegon, the Rifle, and the Thunder Bay Rivers. A region of heavy white pine is found in Otsego County, on the headwaters of the Manistee and Au Sable Rivers, and around

Otsego Lake, on the Jackson, Lansing and Saginaw Railroad, which opens this timber to market, even before the Manistee or the Au Sable have been cleared for lumber purposes. This important center at Otsego Lake is also the center of a large agricultural district, which is already in course of rapid settlement. This railroad (now ending at Gaylord, eight miles from Otsego Lake) is to be extended northward to the mouth of Cheboygan River and Mackinaw, passing through the whole length and along the waters of the Cheboygan district.

4. *Thunder Bay River*, embracing the waters of this stream, and including the county of Alpena, and portions of Alcona, Osceola, Montmorency, and Presque Isle Counties. This district embraces a very large and compact territory, mostly tributary to Alpena, at the mouth of the river on Thunder Bay. This point is a well-known manufacturing center, and as yet holds control of the lumber traffic of the river. A railroad project is however inaugurated from Alpena, in a southwestern direction, and work is already commenced upon it.[1] This road, when completed, will pass through some very large bodies of timber, which are now undisturbed. Manufacturing points along the lake shore, between Au Sable and Thunder Bay, are making inroads into this district, and some of the choicest timber has already been cut off.

5. *Cheboygan district*, including the lake shore and Presque Isle County. This embraces the Cheboygan River and its various waters, and the Oqueoc River and several small streams in Presque Isle County. Lumbering at Duncan and Cheboygan has been carried on for a number of years, and this is an important lumber center, and not less so on account of the prospective advantage of its being the first station on the line of the Jackson, Lansing and Saginaw Railroad. The numerous large lakes and tributary streams in this district give it great importance and value as a lumber region. Its agricultural advantages of soil and location also give it importance. The Oqueoc River, the only principal stream in this peninsula not yet opened, has a large body of pine upon its waters, which, with the natural advantages of this stream alone, will give it importance as a lumber point. The whole of Presque Isle County has more or less scattering tracts of pine within its borders, and considerable lumber has already been shipped from Rodgers City and Crawford's Quarry, the present points of shipment.

6. *The Grand Traverse Region.*—This region, extending from Mackinaw to Manistee, includes the counties of Charlevoix, Antrim, Leelenaw, Grand Traverse, Benzie, and portions of Emmett, Otsego, Kalkaska, Wexford, and Manistee. * * * The pine timber of this region is generally of the first quality. Lumbering at several points has been carried on for many years at Traverse City, Elk Rapids, and Frankfort, taking the timber from Boardman Rapids, Platte, and Aux Becs Scies Rivers. The most important manufacturing establishment in this part of the State is at Traverse City, which has for the last twenty years carried on an extensive business.

7. *The Upper Manistee River.*—This region is described separately as it is as yet undeveloped, lying upon the waters of the Manistee, and extending from its source in Otsego County to the hard-timber ridge in Wexford County, which divides it from the Lower Manistee timber. This is an extensive body of pine, embracing much of the first quality of white pine, easily accessible, and of great value as future supply for the mills at Manistee, at the mouth of the river. The Grand Rapids and Indiana Railroad crosses the lower portion of this body of pine, giving an outlet by rail southward and northward to Traverse City.

8. *The Lower Manistee, the Bay and Little Au Sable, the Pere Marquette, and the Pent Water.*—This district embraces all that region lying west of the Muskegon waters and along the Lake shore from Manistee to Pent Water drained by the rivers above mentioned. The manufacturing points are Manistee, Lincoln, Hamlin, Ludington, and Pent Water. Manistee is a well-known and important lumbering point, and has supplied a large amount of lumber to Chicago. The timber of the lower waters of the river, which has supplied the mills at that point, is more mixed and of inferior quality, as compared with the upper waters just described. At Lincoln and Hamlin, the timber taken from the region drained by the Big and Little Au Sable Rivers has been manufactured. There is a large body of timber on these streams, which will in some measure be affected by the Flint and Pere Marquette Railway, which has just been completed to its terminus at Ludington, passing through Lake and Mason Counties. The southern portion of this district embraces a large, valuable, and compact body of timber, which is traversed by the Flint and Pere Marquette Railway, and, with the abundant water facilities afforded by the Pere Marquette River and the Pent Water, it possesses great value as a lumber region.

9. *The Muskegon River.*—The district embraced by the waters of this stream penetrates the interior of the State, and reaches the waters of streams flowing into Lake Huron, and borders the Saginaw district on the west. The Michigan Lake Shore, the Grand Rapids and Indiana, the Muskegon and Big Rapids, and the Flint and Pere Marquette Railways pass through this district in different directions, and the Jackson, Lansing

[1] Michigan Northern Railway, designed to run from Grand Rapids to Alpena, 200 miles. The report for 1875 shows that $265,000 had been expended.

and Saginaw Railroad touches the extreme headwaters of this river in Roscommon County. The Muskegon of Lake Michigan, like the Saginaw of Lake Huron, is one of the oldest and most extensive pine-producing districts of the State. The Lower Muskegon waters have been largely drained for many years of the timber upon their waters; but the extent of the river and its numerous tributaries afford a field for continued large operations in the future. The stream has been cleared to its source, in Houghton Lake, and timber is now being taken from its banks.

The Muskegon Booming Company was organized in February, 1864, and was chartered by the legislature in the following month. The capital at first $40,000, had been increased in 1872 to $200,000. Their dividend in 1877 is said to have been 20 per cent. The amount of logs delivered annually by this boom is shown by the following table, in which the quantities are given in feet:

	Feet.		Feet.
1864	96,045,814	1872	315,000,000
1865	108,505,700	1873	376,035,037
1866	157,468,300	1874	249,936,412
1867	288,502,200	1875	315,638,418
1868	213,692,600	1876	262,597,265
1869	267,789,900	1877	315,991,775
1870	198,862,600		
1871	250,000,000	Total (14 years)	3,416,066,021

10. *The Grand River District.*—This limited territory embraces some of the choicest of the white pine of the State, which has within a few years appreciated in value, probably much more rapidly than any other timber in the peninsula. This fact is easily accounted for when it is known that the supply for the Grand River lumber trade is limited to the pine of Montcalm County.

THE UPPER PENINSULA.

11. *That region bordering Lake Michigan*, extending from Little Bay de Noquette to the river Saint Mary's, and taking the streams which flow into Lake Michigan. So far as accessibility is concerned, this region should be classed with the Lower Peninsula, as it is tributary to Lake Michigan. There are here extensive and valuable tracts of timber which have to some extent been opened. The Monestique is a large stream with numerous tributaries, all of which are bordered by pine timber of various qualities, with much of the higher grades. The Milacocia River, the Pine and the Carp, and some points on the shore, are also outlets from the pine districts which are attracting the attention of lumbermen.

12. *That district extending from Saint Mary's River to Grand Island, and bordering Lake Superior.*—The pine of this region is of excellent quality, and has attracted the attention of long-timber men. It is well watered by streams with good floating capacity for logs, and is an important lumber district.

13. *The Menominee district*, embracing also the waters of Little Bay de Noquette, the Ford and Escambia and Whitefish Rivers. This region is of course tributary to Lake Michigan, and its water facilities are not surpassed in the State. A very large body of pine is here found, which, more than any other locality, perhaps, is situated so as to be controlled by the owners of the timber. The Menominee is a well-known lumber stream, and yet its upper waters are beyond the reach of present lumber operations. The timber may be preserved with little danger of outside interference. The territory drained by this stream extends into both States, and a large territory in Wisconsin will be lumbered into the Menominee, which is the boundary between the two States.

14. *The Lake Superior district*, covering a large district on the south shore of that lake, and embracing the Sturgeon River, of Portage Lake, the Ontonagon, Presque Isle, Black, and Montreal Rivers, the latter being the State boundary, and embracing districts of timber in both States. There is a considerable amount of valuable white pine in all this territory, which is tributary to Lake Superior, with the present natural market at Duluth.

A further account of the lumber and timber resources of this State will be given under the general article entitled "Lumber interests of the Northwest."

Census statistics of Michigan.

A census is taken in this State once in ten years. The following tables give the results of three of these official returns, so far as they embrace

statements of the production of maple-sugar and the manufactures of wood:

Pounds of maple-sugar made in Michigan, as reported by the State census at three decennial periods.

Counties.	1854.	1864.	1874.	Counties.	1854.	1864.	1874.
Alcona	....	....	....	Leelenaw	34,545	19,832	104,607
Allegan	95,341	289,182	259,738	Leenawee	....	62,898	25,549
Alpena	....	....	1,392	Livingston	13,608	26,219	8,894
Antrim	....	4,050	49,678	Mackenzie	....	14,725	24,100
Barry	95,555	262,373	372,177	Macomb	17,650	32,868	12,076
Bay	....	1,115	300	Manistee	....	1,175	43,944
Benzie	....	....	77,276	Manitou	....	....	....
Berrien	31,271	121,319	51,908	Marquette	....	....	....
Branch	64,779	124,961	79,582	Mason	....	5,327	16,033
Calhoun	14,852	20,129	8,380	Mecosta	....	26,283	42,050
Cass	47,704	132,735	66,276	Menominee	....	860	....
Charlevoix	....	....	54,444	Midland	....	3,913	2,410
Cheboygan	....	9,095	5,501	Missaukee	....	....	5,475
Chippewa	3,700	18,938	10,920	Monroe	11,619	13,916	2,130
Clare	....	....	300	Montcalm	14,246	62,800	83,330
Clinton	125,185	174,183	175,640	Muskegon	....	39,564	46,724
Delta	....	3,850	2,556	Newaygo	800	33,747	54,428
Eaton	213,195	399,643	644,384	Oakland	17,022	35,352	22,800
Emmett	57,268	61,680	101,006	Oceana	....	24,222	79,985
Genesee	57,946	101,212	35,869	Ontonagon	....	500	....
Grand Traverse	100	15,817	58,940	Osceola	....	....	40,518
Gratiot	....	130,987	160,420	Ottawa	44,324	210,753	208,447
Hillsdale	71,508	110,825	111,790	Presque Isle	....	....	600
Houghton	....	29,560	2,600	Saginaw	2,160	26,828	7,717
Huron	....	6,562	3,483	Sanilac	5,497	29,550	4,479
Ingham	93,611	141,799	83,116	Schoolcraft	....	....	300
Ionia	124,368	260,630	285,867	Shiawassee	43,787	95,566	57,356
Iosco	....	....	200	Saint Clair	12,978	44,589	10,572
Isabella	....	29,371	56,204	Saint Joseph	3,530	21,444	7,785
Jackson	100	4,273	820	Tuscola	6,278	66,437	23,342
Kalamazoo	27,388	47,732	48,387	Van Buren	40,877	153,598	74,153
Kalkaska	....	....	32,715	Washtenaw	12,745	21,978	11,000
Kent	114,362	298,194	297,509	Wayne	8,539	19,746	5,285
Keweenaw	....	....	....	Wexford	....	....	59,592
Lake	....	....	27,126				
Lapeer	65,854	109,857	47,609	Total	1,594,292	4,004,762	4,299,793

Mackinac (1854), 17,170; unorganized counties (1854), 18,836.

Manufactories of wood in Michigan, according to the State census of 1874.[1]

Manufactories.	1854.	1864.	1874.
Saw-mills, total number	922	1,073	1,600
Using steam-power	271	531	1,156
Using water-power	618	523	419
Power not reported	33	19	25
Persons employed	4,570	7,747	23,522
Capital invested	....	$6,109,070	$28,448,014
Feet of lumber sawed	302,020,714	621,477,904	3,231,470,894
Value of products	$3,237,036	$8,363,550	$39,850,156
Shingle-mills, total number	....	....	223
Using steam-power	....	....	195
Using water-power	....	....	24
Power not reported	....	....	1
Persons employed	....	....	2,591
Capital invested	....	....	$1,087,220
Value of products	....	....	$2,950,595
Planing-mills, &c., total number	....	....	237
Using steam-power	....	....	197
Using water-power	....	....	36
Persons employed	....	....	2,653
Capital invested	....	....	$2,975,700
Value of products	....	....	$5,174,621

[1]This heading includes planing and turning mills, and sash, door, and blind factories. Hewn timber was generally not reported; one establishment returned as employing 20 men, using $15,000 of capital, and producing $15,000 in value. The same may be said of shingle-bolts, &c.; one establishment returned 4 persons employed, $2,000 invested, and $500 produced. No returns were made of masts and spars, posts, fire-wood, and many other timber products that are known to have been obtained in large quantities.

Manufactories of wood in Michigan, &c.—Continued.

Manufactories.	1854.	1864.	1874.
Stave, heading, and hoop factories	....	....	91
Using steam-power	....	....	85
Using water-power	....	....	1
Persons employed	....	....	1,736
Capital invested	....	....	$903,749
Value of products	....	....	$1,716,687
Barrel, keg, pail, tub, and rim-work factories	....	....	60
Using steam-power	....	....	12
Operated without steam or water power	....	....	33
Persons employed	....	....	1,010
Capital employed	....	....	$944,740
Value of products	....	....	$900,638
Wood faucet, clothes-pin, and wooden-ware factories not elsewhere tabulated	....	....	33
Using steam-power	....	....	25
Using water-power	....	....	3
Persons employed	....	....	523
Capital imvested	....	....	$332,700
Value of products	....	....	$491,347
Wood-bending establishments	....	....	3
Using steam-power	....	....	3
Persons employed	....	....	62
Capital invested	....	....	$43,000
Value of products	....	....	$86,000

Manufactures using wood in part as their material, as reported by the Michigan census of 1874.

Manufactories.	Number of establishments.	Power used.			Persons employed.	Capital employed.	Value of products.
		Steam.	Water.	(?)			
Agricultural implements	70	48	12	10	920	$962,700	$1,409,400
Wagon, carriage, and sleigh factories	143	22	4	117	1,344	1,569,700	1,777,525
Chair factories	93	55	19	19	2,181	2,184,700	2,630,611
Pump factories	23	14	2	7	138	168,200	218,850
Ship-building establishments	12	3	....	......	922	532,000	1,204,000
School furniture	2	1	....	......	33	45,000	60,000
Picture frames	1	1	....	......	10	5,000	5,000
Windmills	4	....	....	......	27	17,500	38,400
Wheelbarrows, hand-sleighs, &c	1	1	....	......	22	14,000	25,000
Piano and billiard-table legs	1	1	....	......	20	20,000	40,000
"Jobbing, wood and croquet"	1	1	....	......	20	16,000	35,000

Establishments incidentally employing forest products.

Manufactories.	Number of establishments.	Power used.			Persons employed.	Capital employed.	Value of products.
		Steam.	Water.	(?)			
Tanneries	63	38	4	......	530	$1,009,350	$1,597,600
Hemlock bark, extract, manufacture	3	3	....	......	35	53,000	16,150
Potash and pearlash factories	8	....	....	......	19	6,200	18,070

KEWEENAW COUNTY.—These notes apply as well to Houghton and Ontonagon Counties, which, together, form Keweenaw Point, a remarkable headland on the south side of Lake Superior, embracing the "copper district" of Lake Superior—being surrounded on every side, except a narrow isthmus, by water, whose temperature averages about 40° Fahrenheit, and at times in winter frozen to a great depth. The climate is cold and severe. The first snow usually falls in September or Oc-

tober, but generally disappears; but by the 1st of November it comes to remain, and is not entirely gone before the last of May or first of June. In winter this region is exposed to terrible storms, which sweep without obstruction over the frozen lake, and the temperature falls to —40° and —42°, in extreme cases, while —20° and —25° are not uncommon. The range of temperature is quite remarkable, being sometimes 50° in 6 hours.

The snows waste rapidly away in spring, without destructive floods, and a short spring passes quickly into a cool summer. The point is traversed by two ranges of mountains, and is dotted with small lakes, some of them having no outlet.

The point bears 75 species of trees and shrubs, of which 72 are native. The principal trees in order of estimated abundance are the white pine, sugar-maple, white cedar (*Thuja occidentalis*), yellow birch, red maple, hemlock, striped maple, aspen, canoe-birch, Norway pine, balsam fir, black spruce, white spruce, tamarack, white and red oaks, poplar-leaved birch, and black cherry. The shad-bush, mountain ash, iron-wood, black maple, red cherry, scrub pine, black and blue ashes, white elm, balsam poplar, and numerous other species are found. It is noticed that the aspen very generally comes in where the forests have been cut off. The chief agency of destruction is fire, which, once started in the forest, will sometimes run over hundreds or thousands of acres.[1] (*Dr. R. Harvey Reed*, Delaware Mine, Mich.)

WISCONSIN.

In 1852, Dr. P. R. Hoy published a short account of the trees indigenous to Wisconsin (*Agricultural Report* 1852, pp. 420–434), with a few remarks describing the size and form of trees, useful qualities, and distribution, with directions for raising forest-trees from seed.

In 1855 a communication was published by the State Agricultural Society from the late I. A. Lapham, of Milwaukee, in which he urged the great importance of taking measures for preserving the forests while they still existed, and of planting before the need of timber should be severely felt. His article of 56 pages was illustrated with outlines of the leaf and fruit of 26 native species, and with short descriptions of nearly or quite all that were known or supposed to grow within the State, with mention of some others that might be cultivated to advantage. Mr. Lapham had previously published a flora of Wisconsin in the Agricultural Report for 1852.

In 1860, J. W. Hoyt,[2] as secretary of the State Agricultural Society,

---

[1] The facility with which a fire will spread through a forest in the Lake Superior region is described in the volume of Professor Agassiz's Exploration, as seen in 1848:

Some of the men, while stopping on the shore (July 15), amused themselves with lighting a fire, which unfortunately ran along the ridge of the beach, and, in spite of their utmost exertions, marched with a broad front into the woods. "It was an exciting spectacle, the eagerness of the flames to seize upon each fresh tree, winding around it like serpents, crackling and rushing furiously through its branches to the top, until every fragment of dry bark, lichen, &c., was consumed. The fire seems too dainty to take the more solid parts, and so, for instance, the bunch of upright cones at the top of the balsams remains distinguishable in the forest as a blackened tuft. One beautiful bear-berry lawn looked now more like a peat-bog. When we left, the fire was in full progress, and was probably stayed only by a swamp beyond. Nature, however, generally provides that no land that can be of much value to man shall be subject to this fate, for the heavily timbered (and thus fertile) land of these latitudes is mostly too wet to burn, except the solitary birches, which, if you set a torch to them, go off like a rocket, but do not set fire to the other trees." (*Lake Superior: its Physical Character, Vegetation, and Animals*, p. 74.)

[2] Present governor of Wyoming Territory.

published a map of the State, showing its general geology, climatology, and the distribution of its timbers, &c., and from the report of the executive committee we condense the following information:

The southern part of Wisconsin is characterized by hard wood, and the northern portion by evergreens. There are many exceptions, but this is a general rule. The timber has a close relation to the geological formation, evergreens belonging to the azoic and sandstone regions, and the hard wood to the limestones. To define more narrowly, the hard woods are confined to the northern three-fourths or four-fifths of the eastern portion of the State, within the counties north of Racine, along the lake, and extending from 30 to 60 miles inland. There are also these forests of considerable extent in other portions of the State; as, for instance, in Green, Grant, Sauk, Richland, and Bad Ax Counties; as also along many of the streams in the evergreen region of the State, but they are rather isolated. The rest of the southern part, and a strip of considerable extent along the Mississippi and Saint Croix, as far as the northern limit of the Potsdam sandstone, consist of prairies and oak openings.

The prairies are small, skirted with timber, and well watered by lakes and unfailing streams. These openings are found in Wisconsin and Minnesota, and are of two kinds—the burr oak and the black oak. The latter belong to the sandy regions, and are not marked by any considerable agricultural capacity. The former are among the most productive parts of the State, being especially adapted to the continued production of wheat. They are, moreover, the most beautiful portions of the varied and picturesque surface of the country. Grouped here and there, like so many old orchards, on the summit of a gentle slope of land, or on the border of marsh, prairie, or lake, there is nothing in the whole catalogue of American sylva that equals these burr oaks for the charming, homelike expression they give to the landscape. The timber they furnish is brittle and of little worth except for fencing and fuel; still, abounding as they do in what would otherwise be a prairie country, and constituting so charming a feature of Wisconsin scenery, they possess a value which is beyond computation.

The evergreens, consisting of white, red, and yellow pines, hemlocks, spruces, firs, and red and white cedars, occupy a large area around the waters that flow into Green Bay and the Mississippi. There are also large quantities of tamarack.[1]

Statistics reported for 1860 showed the production of lumber of Wisconsin as 355,055,115 feet, worth $2,362,558.37, or an average of $6.65 per M feet. The amount of shingles made was 2,272,061 M, worth $1,134,834.51, or about 50 cents per M. The census of 1870 does not admit of a separate calculation of values, the total value of several products being given. The production for the year was 102,663 M of lath, 1,098,199 M feet of lumber, 806,807 M shingles, and $620,591 worth of staves; total value of these, $15,130,719, against $4,616,420 of the returns for 1860.

Discussions in agricultural societies and elsewhere having drawn attention to the subject, both as regards the direct and the collateral benefits to be derived from the maintenance of a due proportion of woodlands, the legislature was a few years later induced to give attention to this subject, beginning with specific inquiries to be prosecuted by a commission.

By "An act relating to the growth of forest-trees," approved March 30, 1867, the State agricultural and horticultural societies were each authorized to appoint one person, and these persons a third one, who were together directed to inquire and make report in detail to the legislature at its next session:

1. Whether the destruction of the forests in this State, now going on so rapidly, is likely to prove as disastrous to the future inhabitants of the State as is claimed by many.

2. Whether such destruction will tend to diminish the moisture of the atmosphere, to increase the degree of cold in winter and the heat in summer, or otherwise.

3. Whether, owing to the want of information in individuals and the shortness of their lives, it is the duty of the State to interfere [interpose] its authority to prevent an undue destruction of forest-trees where they now exist, and to encourage their cultivation where they are deficient.

---

[1] *Transactions of Wisconsin State Agricultural Society*, 1860, p. 46.

4. Whether any and what scientific experiments or investigations should be made to ascertain the best methods of growing and managing forest-trees.

5. Whether the growing of belts of timber along the public roads and highways would afford protection to the same from drifts of snow, and whether these and similar belts in the farms of the State would be beneficial by affording shelter to crops, fruit-trees, buildings, and animals, and add to the health, comfort, and prosperity of the people.

6. Whether any and what convenient substitute for wood may be found in this State, and if by their use the demand for wood will be diminished.

7. To report generally such facts, in a condensed form, as will be of the most practical use to persons desirous of increasing the growth and preservation of forest and other trees.

Their report was to be published in an edition of 3,000, and was limited to 100 pages.

The commissioners appointed were I. A. Lapham, J. G. Knapp, and H. Crocker, and their report is an earnest appeal in favor of tree-planting, specifying the reasons that should lead to planting, the benefits to be derived and the errors to be avoided, with a description of the trees, the State, and the best methods for cultivation.[1]

At the next session of the legislature, laws were passed for the encouragement of tree-planting and for the protection of forest and shade trees, as elsewhere given in this report. We are unable to present any statistics of the exemptions or bounties paid under these acts, nor the amount of planting that has been done.

The absence of means for ascertaining the lumber production of the State, upon which so many interests depend, was noticed by his Excellency Governor Ludington, in his message in January, 1877, and a law was recommended compelling persons cutting logs in the State, to report to the lumber inspector of the several districts, so that a consolidated report might be published.

The State has received considerable grants of land from Congress for schools, a university, and other public trusts, and employs timber agents and clerks for the protection of its interests, as would appear from official reports, with very indifferent success.[2]

Lumbering characteristics of the principal rivers of Wisconsin.[3]

The Chippewa is a large river, with many tributaries coming from the pine region, affording valuable water-power at Eau Claire, Chippewa Falls, and other points, at which there are extensive lumbering establishments, but a large part of the lumber of this stream is rafted down to steam-mills at various points on the Mississippi below. The lowest boom on this river is near its mouth, and is owned by the Beef Slough Manufacturing, Booming, Log-Driving and Transportation Company,

[1] *Report on the Disastrous Effects of the Destruction of Forest-Trees now going on so rapidly in the State of Wisconsin.* Madison, 1867.

[2] Governor Ludington, in his message of 1876, says: "It has become a serious matter to provide against trespassers upon the school and university lands, and the tracts known as the Saint Croix grant. A system seems to have prevailed by which large depredations were committed, and the State was left to secure redress by the collection of stumpage from trespassers. This system is wrong in principle and ruinous in practice. In the nature of things the sums collected in the settlements with the trespassers must be vastly less than the value of the timber taken. If I am correctly advised, it has come to be regarded as a profitable business to strip the State lands of their timber and then effect a settlement. Whatever power rests with the Governor to reform this practice will be vigorously exercised; and if it shall appear that further legislation is necessary to secure that result, I cannot urge too strongly upon you the duty of providing it. The only true policy in dealing with this subject is to prevent depredations, and in this work I urgently solicit your co-operation.

[3] Condensed from the "*Lumber Trade and Manufacture,*" 1874, published by the Northwestern Lumberman, Chicago. 8vo, pp. 112.

formed April 27, 1867, with a capital of $100,000. The amount of logs delivered in 1871 was 12,000,000 feet; in 1872, 53,000,000, and in 1874, 133,000,000. Its rates of toll are 75 cents per 1,000 feet for logs and timber, 2 cents for railroad-ties, and 1 cent for fence-posts. Its capacity is 200,000,000 feet.

At Eau Claire, a lake, apparently once the river-bed, is used as a boom, a canal being opened into the river above and below. It belongs to the Half-Moon Lake and Canal Company, formed December 15, 1856, and sanctioned by an act of March 17, 1859. It was reorganized December 25, 1871.

Various other boom companies have establishments on this river and its tributaries. The recent completion of the Wisconsin Central Railroad affords facilities for lumbering operations on the upper waters of this river. The West Wisconsin Railroad also crosses this river.

The Black River afforded to mills below on the Mississippi 120,000,000 feet in 1871, 114,000,000 in 1872, and 134,000,000 in 1873. This stream is shorter than the other lumber rivers of Wisconsin; its waters are rapid and quickly affected by rains and freshets, and it flows through a broken country, its banks being bordered by high cliffs. The timber along its course consists of pine, hemlock, cedar, oak, ash, maple, bass, elm, &c. The principal manufacturing points on the river are at La Crosse, at the mouth, where there are ten establishments with a capacity of 92,000,000 feet a year, and at Black River Falls, where three establishments have a capacity of 60,500,000. The valley is crossed by the Chicago, Milwaukee and Saint Paul Railroad, the Chicago and Northwestern Railway, the West Wisconsin Railroad, and the Green Bay and Minnesota Railroad.

The Black River is a very difficult stream to operate, and the driving of logs is attended with much labor, as the floods are of short duration and logs can move but a short distance at a time, and are apt to be piled up in jams with drift-wood, which renders them liable to fires. A patrol is found necessary to guard against this accident. Sometimes several seasons pass before logs started on the upper waters reach the boom at La Crosse. Very few reach the mills till the second summer after they have been banked.

The Wolf River flows through an extensive region in the eastern part of Wisconsin which abounded in pine forests, with a considerable amount of hard-wood timber. The lands as they are cleared are being occupied as farming lands. The upper waters are rapid, with a comparatively steady flow. The country along the lower waters is quite level, the bottoms wide and heavily timbered with hard woods where not cleared. The pine region is more elevated and broken. Its booming capacity is fine, and Bay Boom, in a bay of Boygan Lake, has a capacity of 100,000,000 feet. Pine River, a tributary of the Wolf, has much hard-wood timber along its course, and fine groves of pine. It is crossed by the Wisconsin Central and Green Bay and Minnesota Railroads.

The Wisconsin River,[1] and its tributaries drain an extensive pine-forest region, with lumbering points at Port Edwards, Grand Rapids, Stevens Point, Mosinee, Wausau, and Necedah. The river is rapid, with frequent sites for hydraulic power. The Stevens Point Boom Company, formed October 26, 1873, has a boom capable of holding 100,000,000 feet, and the Garrison boom at Grand Rapids may be increased to like amount. The Wisconsin Central Railroad crosses the valley diagonally.

Green Bay district.—The shores of this bay are low, and gradually

[1] A particular description of the valley of this river is given in the *Report of the Chief of Engineers* (U. S. A.), 1876, Part II, p. 254.

change from marsh to swamp, then to level dry land, and finally become broken and mountainous. The pine is in dense groves that crowd closely upon the swamps that skirt the bay, and reach back among the hills of the interior. They are interspersed with hard timber. The rivers tributary to the bay are the Escanaba, Cedar, Menominee, Peshtigo, Oconto, Pensaukee, Little and Big Suamico Rivers, and the Fox. The first two have but little lumbering. The Menominee is by far the most important, and the mills are chiefly at Menominee on the north or Michigan side, and at Marinette and Menekaune on the south or Wisconsin side. The main boom is just above the rapids, where a dam sets the waters back a long distance, the pressure of the logs being partly borne by piers and lines of piles set at short distances over the pond. The river is the only limit to the capacity of the boom.

From an article on the timber lands of the Northwest,[1] the following statement is given of the timber resources of Wisconsin:

1. That district embracing waters of Lake Michigan, south of the Menominee, the Fox River, the Pike, Pine, Peshtigo, and other small streams, all have been occupied for years, supporting an important lumber traffic, and supplying to a great extent the demand of Chicago. The timber of this region, particularly that upon the Wolf and Fox Rivers, embraces some of the best timber of the State.

2. *The Wisconsin River district* extends from south to north, and embraces, along the waters of the river, very large tracts of timber, reaching to the Menominee waters, and overlapping the Wolf and Fox Rivers districts.

3. *The Chippewa River and its waters.*—A very extensive district, embracing the whole of the central portion of the State, and extending from near the waters of Lake Superior to the Mississippi. The remarkable water facilities of this stream will be observed by reference to the map. The Wisconsin Central Railroad [recently completed] penetrates a large portion of the pine region tributary to this stream.

4. *The Saint Croix River district* embraces the western portion of the State, and extending north and south between the Mississippi and Lake Superior.

5. *The Lake Superior district*, embracing the slope on the border of Lake Superior, from the Montreal River to the western boundary of the State; all tributary to Duluth, Superior City, and Ashland. This district is drained by numerous streams, which have sufficient capacity for floating logs. At Ashland the Wisconsin Central Railroad has its terminus.

The lumber and timber resources of this State will be given under the general article entitled "Lumber Interests of the Northwest."

Proposed Wisconsin State park.

The late Hon. Increase A. Lapham, of Milwaukee, suggested the formation of a State park, embracing some forty townships, or 1,440 square miles, around the headwaters of the Wisconsin, Chippewa, and other rivers, and bordering upon the Upper Peninsula of Michigan. This region abounds in lakes, and besides being an agreeable place of resort by sporting parties, it affords an opportunity for maintaining reservoirs for equalizing the flow of waters, by saving the excess of the winter and spring seasons for the wants of summer and autumn. No action has, however, been taken toward securing this end.

Similar conditions are presented around the headwaters of the Mississippi, in the State of Minnesota, which may hereafter claim the attention of the public in that State.

MINNESOTA.

The first report of the Commissioner of Statistics of this State (1860) gives the following account of the natural distribution of its timber:

The Great Coniferous District.—The elevated and broken region north of latitude 46° and east of the meridian of the outlet of Red Lake may be described in general terms

[1] Written by George S. Frost, and published in the *Lumber Trade and Manufacture*, 1874, p. 46.

as *a forest country*, these lines, in general, being the southern and western limits of the pine and other coniferæ in Minnesota, and including an area of 21,000 square miles. Pine is the prevailing wood of this district, but intermingled with a considerable proportion of birch, maple, aspen, ash, and elm. The alluvial bottoms of the extreme northern branches of the Mississippi support a heavy growth of basswood, elm, aspen, butternut, ash, birch, hard and soft maples, linden, balsam-firs, and some oaks. It is observed that whenever the cone-bearing woods are burned off in this district, the hard woods take their place. The sugar-maple, which, according to Blodgett, markes the range of Indian corn, extends northward nearly to Rainy Lake, where it yields abundance of sugar to the Indians. In the Red River Valley, the sugar-maple is found all along its trough, and finds its northern limit beyond the 49th parallel, on the elevated southern water-shed of Lake Winnipeg. On the rivers flowing into Lake Superior, hemlock, cedar, spruce, fir, and birch prevail.

The Zone of Pine.—The principal pine forests of Minnesota, which constitute one of its main resources of industry and wealth, stretch in a broad belt near the southern border of the great northern forest district, from the eastern side of Pine County, in the Upper Saint Croix Valley, northwestward across the water-shed to the outlet of Red Lake. The principal pineries where lumber is bought are upon the headwaters of Kettle, Snake, Rum, Crow-Wing, and the Upper Mississippi, and recently upon the extreme upper waters of the Red or Otter Tail River.

Belt of Oak Openings.—Below latitude 46°, the pine, hemlock, spruce, birch, and all the *Coniferæ*, generally disappear with the forest-line. A narrow range of cedar and tamarack swamps between Saint Croix and Crow Wing Rivers, and some pine, mingled with large maple, oak, ash, and small birch and spruce, intervene for half a degree further, when the oak becomes the prevailing tree on the uplands, distributed in groves and large parks, its growth usually dwarfed by the annual ravages of prairie fires. These oak openings characterize the whole delta of rolling prairie below latitude 45° on the east side of the Mississippi. The soft maple, elm, ash, willow, and alder, line the bottoms of the Rum and Elk Rivers. There are no compact forests in this section, except upon the Saint Croix Valley, where a dense mass of hard-woods, in which the sugar-maple prevails, occupies the upper part of Washington and Chicago Counties to the pine belt in Pine County.

The Bois Franc, or Big Woods.—West of the Mississippi the western flank of the great coniferous forest of the north, extending with a thick border of hard-wood west of Otter Tail River, and around Otter Tail Lake, terminates upon the valley of the Crow Wing, where it merges its characteristics in a new forest growth of the deciduous forms, which stretches in a broad angular belt across the great prairies of the southeast and south, and generally known as the Big Woods. This belt of wood forms a deep fringe, of from ten to twenty miles in width, along the western slope of the Mississippi, from the Crow Wing Valley to the Sauk at Saint Cloud. Crossing into the valley of the Crow River, and keeping a general southeasterly course, it occupies a large strip of country between the Mississippi and Minnesota Rivers, nearly one hundred miles on its longest side, with an average breadth of forty miles; its western limit being formed by a line crossing the counties of McLeod and Meeker, diagonally through the middle, and its eastern by a line drawn from near the mouth of Rum River to Carver, on the Minnesota. Throwing its left flank across the Minnesota at Louisville, its main body crosses the river between Belle Plaine and Le Sueur, and covers nearly the whole of Le Sueur County, with its right wing extending southwestward to Blue Earth River, in Blue Earth County, and its left occupying about one-half of Rice and Scott Counties. The area of the tract of country covered by the Big Woods is about 5,000 square miles, of which 4,000 is occupied by the division north of the Minnesota, and 1,000 by its southern division. This woodland district is full of lakes, and, in some sections, the dense mass of forest is broken by small prairies. The varieties of timber in this district are mainly oak, maple, elm, ash, basswood, black walnut, and hickory.

Southern Belt of Valley Woods and Oak Openings.—Besides the tract above described there are no large forests in Minnesota west of the Mississippi. But nearly all the streams have narrow fringes of woodlands, and some of the valleys east are dense masses of timber. The wide bottoms of Minnesota and Mississippi have a deep border of thick and massive woods, in which the large cottonwood and maple are conspicuous, with white and black walnut, butternut, linden, boxwood, and hickory. The Zumbro Valley, Wabashaw and Dodge Counties, supports some large tracts of forest growth. The Root River also affords a considerable body of thick woods on the borders of Fillmore and Olmstead Counties, in which all the varieties of the Big Woods are reproduced. But the oak-openings and groves which are scattered through the uplands along the streams form a large resource of the prairie population for domestic and mechanical purposes.

The Sparsely Wooded District.—The Upper Valley of the Minnesota and Red River sustains no forest-growth, except upon the trough of the main and tributary streams and the margins of the lakes. The minor streams of the Upper Mississippi are, however,

poorly timbered, a few scattering trees only marking their course over the naked plain.

On the Red River a narrow fringe of thick woods of the hard varieties commences at Graham's Point, and continues to Pembina, while all the streams on the east and west sides afford narrow strips of timber, generally from 15 to 25 miles apart, while the intermediate plains above latitude 46° are dotted with clumps of poplars, willows, and other aspenoids.

The boundaries and characteristics of the "Big Woods," which form a spur extending from the great wilderness of Northeastern Minnesota southwestward along the valley of the Minnesota River, and nearly to Iowa, are described in an article by N. H. Winchell, published in the Transactions of the State Horticultural Society, winter session, January, 1875, p. 47. The term is strictly applicable only to the Lower Minnesota Valley, and the native outlines are very irregular, with isolated tracts in some places. In this region some forty-five species of wood-bearing plants are enumerated.

The existence of this spur of woodlands extending into the prairie region, and successfully resisting the fires that annually ran over this country in former years, may justly be regarded as a phenomenon in natural history worthy of careful study. It is noticed that its fauna differs from that of the prairies, including the bear, wolf, deer, and birds in great abundance, and it cannot fail of exerting a beneficial effect upon the climate of that region. It abounds in small lakes, and is as yet but sparsely settled.

A catalogue of the plants of Minnesota was prepared by I. A. Lapham, of Milwaukee, in 1865, and is published in the Transactions of the State Horticultural Society, January, 1875. As it gives no indications of locality, abundance, or other facts beyond the name, we deem it proper only to mention that it embraces fifty-seven species of timber-trees, or large shrubs, and seventy-nine species of the minor woody plants and vines.

From the description of the State above given, it will appear that Minnesota presents at the same moment an example of present abundance and of extreme scarcity in a more marked degree than any State east of the Mississippi, and that while on one side extensive lumbering operations are going on, and new enterprises are being undertaken, under the delusive appearance of "inexhaustible supply," the most urgent need of timber-planting is felt on the other, not merely to create a supply of material for fuel and farm purposes, but to afford protection to man and beast and to farm and orchard against the fierce northern winds of winter, and the drying southwest winds of summer.

The necessity of timber-belts as a shelter from storms was never, perhaps, more severely felt than in a storm of memorable severity, which swept over several of the Northwestern States on the 7th, 8th, and 9th of January, 1873, where, in the absence of such protection on the prairies, suffering and death were reported from very many points. This storm was particularly severe in Minnesota, but it was felt with great force over a region extending from Manitoba and Dakota to Wisconsin and Illinois, and in Kansas and Nebraska. With this experience in the memory, arguments were not needed to show the value of a closely-planted belt of forest-trees around the farm-buildings and along the highways, and the public discussions upon this subject have tended to awaken an interest in the question of plantations for shelter, that promises to be of lasting good.

In a communication addressed to Gov. C. K. Davis, January 29, 1874, by Mr. Leonard B. Hodges, in speaking of the treeless region in Minnesota—he takes three counties (Stevens, Grant, and Wilkin) as a fair

average of twenty-five large counties in Western Minnesota, in which timber-planting may be regarded as an urgent necessity. These three counties, with an area of about 1,198,280 acres, had, in all, but 1,279 acres of scattered timber, or about one-tenth of an acre of timber to one hundred acres of prairie.

The necessity of taking some measures for the encouragement of planting was urged upon the legislature by Governor Davis in the winter of 1874, and a bill was introduced in the senate by Senator Donnelly, providing for a system of forest-tree culture, and the appointment of a State commissioner to supervise the work of planting a thousand miles of the leading highways with quick-growing timber. This passed the Senate, but was lost in the House.

This delay did not dishearten those who realized the great public necessity involved, and two years after the discussion resulted in a manner somewhat differently from that first intended, but perhaps quite as directly toward the accomplishment of its main purpose, in the organization of the

Minnesota State Forestry Association.

This, the first, and hitherto the only State forestry association within the United States, was formed at Saint Paul, January 12, 1876, in pursuance of a call signed by many leading citizens of the State, who realized the importance of taking effectual measures for protecting the existing timber resources of the State, and of making provision against future wants. At the first meeting, held January 11, a committee, consisting of Gen. George L. Becker, Ex-Gov. William R. Marshall, Leonard B. Hodges, Prof. Charles Y. Lacy, William Elliott, L. M. Ford, and Prof. William W. Folwell, was appointed to draught a constitution, which was adopted the next day at an adjourned session, as follows:

Constitution of the Minnesota State Forestry Association.

ARTICLE I. This society shall be known as the Minnesota State Forestry Association.

ART. II. The object of this association shall be the encouragement and promotion of forest-culture by the collection and diffusion of practical information on that subject, and by the discussion of all questions pertaining thereto; to secure the general observance of Arbor Day throughout the State, and to promote the ultimate redemption of the treeless regions of Minnesota.

ART. III. The officers of this association shall consist of a president, one vice-president from each Congressional district, a secretary, a treasurer, and an executive committee, consisting of the president, secretary, and five elective members.

ART. IV. The president shall preside over all meetings of the society, and deliver an annual address on the subject of forest-culture in Minnesota.

ART. V. In the absence of the president, his duties shall devolve upon the vice-presidents in their regular order.

ART. VI. The secretary shall record all transactions of the society; shall collate, edit, and prepare all work for the press; shall receive and answer all communications addressed to the society; shall establish and maintain correspondence with similar associations, and secure by exchange their transactions as far as possible. He shall give full and general notice of all meetings of this society through the public press of the State. He shall report and submit to the annual meeting of the society all matter that has come into his possession, which, with its approval, shall become a part of the transactions of the society. He shall receive and pay over all moneys received from members or otherwise to the treasurer, from whom he shall take a receipt therefor.

ART. VII. The treasurer shall collect and be held responsible for all funds of the society, and shall disburse the same only on the order of the executive committee.

ART. VIII. The officers of this society shall be elected annually by ballot, and shall hold their offices until their successors shall be elected.

ART. IX. Every member shall be entitled to copies of the transactions of the society, as often as the same shall be published, and it shall be the duty of the secretary to forward the same to each member by mail, express, or otherwise, immediately after publication.

ART. X. The executive committee may call a meeting of the society at any time and place they may deem advisable by a notice of at least ten days in the public press.

ART. XI. The society shall hold annual sessions on the second Tuesday in January of each year, at such place as the executive committee shall determine.

ART. XII. Any person may become a member of this society by the payment of $1 to the secretary.

ART. XIII. It shall be the duty of the executive committee to prepare a programme of exercises for each annual meeting, assigning to each division of arboriculture an essay or paper to be furnished by some member specially qualified for this service.

ART. XIV. The president and secretary shall have power to appoint delegates to meetings of kindred associations.

ART. XV. This constitution may be amended by a vote of two-thirds of the members present at any annual meeting.

Under this organization, the officers first elected were, E. F. Drake, of Saint Paul, *President;* A. A. Soule, of Cottonwood County (first district), Ignatius Donnelly, of Dakota County (second district), and John H. Stevens, of Hennepin County (third district), *Vice-Presidents;* Leonard B. Hodges, of Saint Paul, *Secretary;* Pennock Pusey, of Saint Paul, *Treasurer;* and Prof. C. Y. Lacy, of the State University, G. W. Fuller, of Litchfield, C. F. Dunbar, of Faribault County, John P. Schoenbeck, of Nicollet County, J. W. Blake, of Lyon County, with the *ex-officio* officers above named, as *Executive Committee.*

The State legislature, by an act passed March 2, 1876, appropriated $2,500 to promote the objects of the Association, and in order to perfect the organization and remove all doubts as to legality, it was deemed proper to reorganize under the general laws of the State, which was done in due form on the 23d day of November, 1876.

The means provided by State grant, and dues from members, enabled the society to offer a series of premiums, which, although not large in amount, were sufficiently numerous to stimulate competition, and the objects and plan of the society were widely published in time for the planting season of 1876. The first Tuesday of May was fixed upon as Arbor Day, and every citizen owning land was invited to devote this day especially to tree-planting.

The amount of premiums offered in each county was as follows:

For the greatest number, not less than 7,000 cuttings or 2,500 trees, planted by one person on Arbor Day, $10.

For the second greatest number, not less than 4,000 cuttings or 1,500 trees, $5.

For the third greatest number, not less than 2,000 cuttings or 1,000 trees, $3.

For the fourth greatest number, not less than 1,000 cuttings or 500 trees, $2.

To the boy or girl under ten years of age in each county who planted not less than 10 trees or 20 cuttings, a centennial medal or badge.

To the boy or girl in each county under 14 years who planted the greatest number on Arbor Day, not less than 2,000 cuttings or 1,000 trees, $5.

For the second greatest number, as above, not less than 500 trees or 1,000 cuttings, $2.

Besides these premiums, the Hon. F. R. Delano, of Saint Paul, offered to pay to the association $50 annually, for 5 years, for the man, his wife, and children, who, in any one of the strictly prairie counties of Minnesota, should plant the most trees and cuttings of all kinds during the planting season. The Pioneer Press Company and the Saint Paul Dispatch Company, also each offered premiums to stimulate competition in planting.

In 1877, the sum of $2,000, in addition to a balance then remaining of the former grant, was appropriated by the legislature.

The result of these measures is shown in the planting of from eight to ten millions of trees. The rules for regulating payment of the rewards provided that the trees should be alive and show evidence of care in October following; each competitor was to plant his own trees, or

in case of sickness or absence to employ a substitute; the plantation was to average not less than 2,500, nor more than 4,356 trees to the acre; a count and report was to be made before June 1; and a sworn statement was to be forwarded in October, setting forth the number, kind, how planted and cultivated, cost and average size of the trees planted; all planting was to be for permanent belts or groves and not for sale, except as thinnings. There was to be no clubbing, or joining of timber plantations upon lands owned by different parties, to secure premiums.

For medals, the association decided upon a piece in silver, of coin standard, and of the size of a silver dollar, pierced for a ribbon and furnished with a case. Each medal was to have stamped on one side a wreath of forest leaves to encircle the same; and on the reverse the words "Minnesota State Forestry Association, 1876," around the edge, and an oak tree in the center. Acorn badges in silver were also provided, with pins for wearing upon the dress.

Mr. L. B. Hodges, of Saint Paul, the secretary of the association, in a letter dated November 29, 1877, gives the latest returns of operations for that year.

> The spring planting, reported by the several township assessors, amounted to 5,268,939 trees, of which 502,568 were planted on Arbor Day. The returns of fall planting are coming in by every mail, and will come in till January. The total amount for the year 1877 cannot fall short of 7,000,000, and will probably reach 10,000,000, forest trees planted in Minnesota during the entire planting season.

The returns of assessors are regarded by Mr. Hodges as very incomplete, as it is an extra service for which no pay is allowed, and many appear to take no pains to get full returns. As to the proportion of these ten millions of trees that have been planted under the stimulus of premiums offered by the State, there are no means of knowing. We know that some would have planted without special inducement beyond self-interest.

Unlike the experience of the more humid regions of the Atlantic States, timber-culture west of the Mississippi has difficulties to encounter which require energy and patience to overcome. During the past summer, in some ten or twelve counties of Minnesota, the grasshoppers proved very destructive to young trees, especially to seedlings. The correspondent just quoted mentions the following as within his experience:

> In October and November, 1876, I planted 16 acres very thickly with cottonwood and willow cuttings, ash-seed, and box-elder seeds, with a few thousands of cottonwood yearlings. Nearly all from seeds and cuttings came up well, and on the 1st of June last that patch of 16 acres of young forest trees on the broad prairie was a beautiful sight. But during the months of June and July they were nearly all devoured by the "hoppers." I have this fall replanted the same ground, and more too. May not grasshoppers, as well as fire, be one of the chief causes of the treeless region?

The State commissioner of statistics, in reporting for 1876, says that estimates, based upon the returns received, show that a million and a half of trees were planted on Arbor Day in 1876, and ten millions during the season. Of these about 70 per cent were alive and in healthy, growing condition October 15. In noticing the results, he says:

> Indeed, from the sworn statements of parties competing for premiums, we ascertain that in a large majority of instances, when the work was properly and intelligently performed, when the ground was properly fitted up, and the necessary *cultivation* given at the proper periods during the growing season, that the percentage of loss is surprisingly small—in many instances less than 10 per cent. In analyzing the returns, we find a very large proportion of the tree-planting has been done where there is the

most pressing necessity for this kind of work, viz, in the treeless region and the counties bordering thereon. For example, Faribault County, with an area of 460,800 acres, had, at the time of the United States survey, 20,300 acres of timber, being about $6\frac{1}{4}$ acres to each quarter-section, if proportionately distributed; enough to entice settlers into it, but not enough to last them forever. This county, realizing her necessities in this regard, has distinguished herself by planting, as reported by assessors, on Arbor Day 195,278 forest trees and cuttings, and during the entire season the enormous number of 1,804,776, clearly entitling her to the appellation of the "Banner County," as awarded by the State Forestry Association.

Nobles County, with an area of 460,000 acres, had at the survey but 40 acres of timber. The assessors report in this country 121,052 trees planted on Arbor Day, and 693,343 during the season. In the southwestern group of counties, intersected by or tributary to the Southern Minnesota Railroad, the Saint Paul and Sioux City Railroad, and the Winona and Saint Peter Railroad, in all fifteen counties, lying south of the Minnesota River, and having together an area of 6,216,680 acres, and an average native supply of only $1\frac{1}{3}$ acres to each quarter-section, there were planted on Arbor Day 799,348 trees, and during the season 5,084,882 forest trees and cuttings, or more than half the whole amount in the State. In another group of counties, equally destitute of timber, on or near the Saint Paul and Pacific Railroad and the Hastings and Dakota Railroad, lying north of the Minnesota River, comprising ten counties and 4,753,400 acres, there were planted on Arbor Day 279,825 forest trees and cuttings, and during the season 898,431.

The assessors report over 400 miles of windbreak and hedges as planted during the season of 1876 on farms bordering upon highways.

Mr. John H. Stevens, of Minneapolis, in writing to the Department of Agriculture upon tree-planting in Minnesota, mentions the white, green, and black ash, aspen, long-toothed poplar, linden, yellow and white birch, black walnut, butternut, box elder, cottonwood, red and black cherry, elms of several kinds, hackberry, shagbark and bitter-nut hickories, red mulberry, several of the maples and oaks, and willows, tamarac, and many smaller trees and shrubs, as adapted to cultivation in that State. As a rule the evergreens had not done well, and the list of those that might be planted with much chance of success, were the pine, balsam fir, swamp spruce, red and white cedar, and juniper.

Mr. Stevens insists upon the thorough breaking up of the sod before planting, and advises that a hoed crop should be first cultivated so that the native sod shall be thoroughly pulverized and rotten. After the crop is removed the ground should be plowed deep and then harrowed. He would set the cuttings deep and cultivate so as to destroy all weeds and grass. He commends the white willow and Lombardy poplar for windbreaks, and the buffalo berry (*Shepardea argentea*) as a hedge plant. In starting the oak, he would plant the acorn where the tree is wanted, as it is not easily transplanted. In some instances he had known a cottonwood of fifteen years' growth make a cord of wood. The black walnut and butternut are well worthy of cultivation, especially the former, which grows rapidly and is quite valuable. The locust had very often failed, but it was hoped that it might yet succeed. He is confident that tree-planting may be successfully undertaken throughout Minnesota and Dakota, and that prairie farms may be easily kept supplied with all the wood needed for farm uses and for fuel, by proper care and management.

Statistics of tree-planting in Minnesota.

The eighth annual report of the Assistant Secretary of State and Commissioner of Statistics, embracing the returns for 1876, shows the following results of forest-tree planting by counties:

Counties.	Planted on arbor day, 1876.	Planted in season of 1876.	Whole number planted and growing.	Rods planted on highways and on farms.
Becker	6	169	2, 724	10
Big Stone	....	41, 200	50, 300	....
Blue Earth	18, 245	113, 561	690, 897	14, 457
Brown	51, 663	102, 529	649, 947	7, 362
Chippewa	24, 508	105, 092	242, 904	1, 070
Clay	200	17, 650	23, 870	....
Cottonwood	90, 020	451, 201	541, 221	....
Dakota	236	16, 578	259, 057	7, 440
Douglas	2, 620	15, 497	181, 780	3, 718
Faribault	62, 433	1, 582, 641	3, 405, 905	19, 230
Fillmore	1, 562	25, 400	218, 019	4, 100
Freeborn	7, 160	194, 138	2, 277, 961	8, 386
Goodhue	5, 427	11, 279	811, 477	11, 679
Grant	8, 576	77, 087	48, 657	....
Hennepin	2, 964	6, 342	41, 874	280
Houston	47	50	20, 022	....
Jackson	29, 238	349, 565	1, 293, 022	4, 521
Kandiyohi	8, 127	147, 662	360, 006	295
Lac-qui-Parle	12, 743	125, 678	293, 523	......
Le Sueur	1, 150	436	5, 250	350
Lincoln	100	10, 870	16, 941	....
Lyon	49, 553	216, 931	912, 892	....
McLeod	15, 796	84, 479	100, 275	288, 897
Martin	148, 677	567, 697	3, 226, 046	8, 046
Meeker	38, 641	30, 276	145, 260	170
Mower	6, 895	210, 830	1, 554, 099	2, 739
Murray	1, 955	106, 193	180, 599	....
Nicollet	7, 540	44, 915	227, 221	385
Nobles	63, 120	536, 232	1, 956, 050	....
Olmsted	6, 645	8, 679	229, 907	9, 688
Otter Tail	5, 136	11, 503	15, 189	80
Polk	262	100	182	....
Pope	4, 850	30, 554	100, 281	550
Ramsey	2	457	3, 090	600
Redwood	17, 671	132, 613	403, 923	1, 588
Renville	16, 399	182, 700	749, 710	772
Rice	10	767	104, 075	25
Rock	22, 890	466, 247	786, 320	9, 604
Sibley	64, 612	122, 640	383, 583	1, 834
Stearns	10, 247	54, 802	122, 964	742
Steele	4, 747	10, 853	707, 689	5, 540
Stevens	16, 770	116, 525	461, 025	800
Swift	9, 060	26, 910	125, 932	220
Todd	480	1, 793	2, 749	....
Wabasha	2, 855	18, 778	473, 460	4, 507
Waseca	7, 224	90, 773	814, 075	830
Watonwan	52, 649	219, 775	953, 699	3, 387
Wilkin	3, 000	4, 570	4, 786	....
Winona	130	2, 928	18, 598	760
Yellow Medicine	23, 746	105, 766	237, 952	....
Total	928, 581	6, 792, 911	26, 437, 088	424, 662

[1] No returns are published from the counties of Aitkin, Anoka, Benton, Carlton, Carver, Chisago, Crow Wing, Dodge, Isanti, Kanabec, Lake, Mille Lacs, Morrison, Saint Louis, Scott, Sherburne, Wadena, Washington, and Wright—19.

The above table is from the *Statistics of Minnesota* for 1876, p. 85. Another table from returns made by assessors in the same report, pp. 161–181, is imperfect in many respects, but more in detail as to planting by townships. The numbers in some cases agree with those in this table, and at other places they largely exceed them.

In another part of this report an account is given of the planting done by railroad companies, and statistics of the lumber production.

In relation to the latter it may be remarked that measures are now in progress for opening the region drained by the Saint Louis River by the construction of a short line of railroad from the Saint Paul and Duluth Railroad to a point on the Saint Louis favorable for the location of saw-mills. We have no statistics of the resources particularly the object of this enterprise. The hydraulic power along this river is enormous, and up to the present time almost wholly unimproved, although railroad facilities and lake navigation offer great opportunities for manufacturing enterprises in this region.

The Minnesota State Horticultural Society has for several years proved an efficient agency for awakening an interest in tree-planting, by the discussions that have been had and the publications it has issued. It has been its practice for several years to recommend lists of trees found worthy of confidence, from the experience of its members. The society in January, 1874, continued its list of the previous year, which then stood, with some additions, as follows:[1]

Shade-trees for streets and lawns.—White elm, basswood, white ash, box-elder, soft maple, sugar-maple, butternut, walnut, and hackberry.

Ornamental trees.—Mountain ash, white birch, European larch, and Kentucky coffee-tree.

Evergreens.—1, Norway spruce; 2, Austrian pine; 3, Scotch pine; 4, balsam-fir; 5, American arbor vitæ; 6, American black spruce; 7, white spruce; 8, red cedar (when clipped); 9, Siberian arbor vitæ, for small yards.

In a discussion in the society in 1875 the merits and defects of various evergreen trees were again considered in the light of further experience, and the result gave the following classification in order of preference, with the vote for and against, the vote being on placing 1st, 2d, &c., on the list, to the 12th:[2]

	Vote.		Vote.
1. White spruce	10 to 8	7. Red cedar	11 to 4
2. Norway spruce	11 to 8	8. Red or Norway pine	11 to 0
3. Scotch pine	13 to 0	9. Austrian pine	9 to 7
4. Balsam-fir	15 to 0	10. Mountain pine	8 to 0
5. White pine	11 to 0	11. Siberian arbor vitæ	14 to 0
6. American arbor vitæ	11 to 2	12. Trailing juniper	13 to 0

It is noticed that where fires were kindled in the underbrush of our oak thickets, and thus tracts were burned over, the dead trees became filled with the larvæ of *Elaters* and other destructive insects, which were in this way suddenly increased in numbers. A suggestion from this fact might apply to allowing dead timber to remain standing anywhere in large quantities.—(*C. L. Herrick*, Minneapolis, Minn.)

Amount of maple sugar and sirup made in Minnesota through a series of years.

Years.	Pounds of maple sugar made.	Gallons of maple sirup made.	Years.	Pounds of maple sugar made.	Gallons of maple sirup made.
1860	353, 337	24, 403	1872	195, 587	17, 394
1868	250, 467	14, 105	1873	139, 952	17, 541
1869	197, 742	14, 196	1874	145, 285	17, 246
1870	231, 602	17, 320	1875	151, 215	31, 546
1871	141, 982	22, 923	1876	47, 022	10, 414

It is noticeable that many of the valleys, particularly those running east and west, as Crooked Creek Valley, have the bluffs along the north side of the creek destitute, or

[1] *Transactions*, p. 60.
[2] *Transactions*, summer meeting of 1875, and winter, meeting of 1876, p. 134.

nearly so, of timber, but are heavily timbered along the opposite bluffs on the south side. This may be due to warm days in winter or early spring when the sap may have started in the trees on the north bluffs, followed by severely cold weather before the actual setting in of settled warm weather. The sun's heat would be most felt on the bluffs facing south, and this process repeated many years might injure and destroy the trees.[1] —(*Geolog. Survey of Houston County, Minn.*, p. 18.)

NOBLES COUNTY:

Much attention has been given to tree-planting, and there is scarcely a claim or a farm on which from one to ten acres have not been started. The season of 1874 was a very poor one for trees, owing to drought. Tens of thousands of white-willow and cottonwood cuttings were planted with soft-maple seed, but probably not one in a thousand came up. The following experience shows the difficulties sometimes encountered in tree-planting in this county:

I planted about 20 acres of soft maple and 2 of cottonwood, and have nothing to show for it. The grasshoppers cut off the few soft maples which sprouted, and the cuttings dried up in the ground. I made a discovery with box-elder seed which is probably worth mentioning. During the winter of 1872–'73 we sold from the Colony office, for other parties, quite a quantity of box-elder seed which were planted throughout the county. Very few of the seeds sprouted, and there was a general complaint at the apparent worthlessness of the seed. Most of those who planted plowed up the ground used and prepared it for other crops. My ground was unmolested until the spring of 1874, when what was my surprise to find the little box-elders pushing through the ground by hundreds, after having laid over one season. There are several groves in this county which have been remarkably successful. One of these was planted by the railroad company for a snow-break, about two miles west of the town. Some 1,500 cottonwood and European larches were set in alternate rows in the summer of 1873. Last fall I took a stroll through this grove, and found many of the cottonwoods 10 to 15 feet high, and the larches doing well.—(*A. P. Miller*, Transactions of Minn. Hort. Soc., winter meeting, Jan., 1875, p. 50.)

LUMBER INTERESTS OF THE NORTHWEST.

Under the headings of the several States, we have already given many details of lumber production. The following tables, prepared from data collected by journals of recognized authority, and specially in the interests of lumbermen, will show collectively a comparison of results for the three recent years that deserve careful attention.

Shingle product of 1874, 1875, *and* 1876 *in the principal Lumber Districts of the Northwestern States.*

[From the *Northwestern Lumberman*; March 17, 1877.]

Lumber districts.	1874.	1875.	1876.
Eastern shore of Lake Michigan	29, 500, 000	67, 350, 000	87, 000, 000
Saginaw Valley, Michigan	90, 500, 000	111, 600, 000	116, 250, 000
Miscellaneous mills tributary to Lake Michigan	120, 675, 000	208, 800, 000	272, 690, 000
Chicago and Michigan Shore Railroad, Michigan	50, 500, 000	133, 150, 000	149, 375, 000
Detroit and Bay City and Chicago and Lake Huron Railroads	70, 600, 000	84, 900, 000	89, 775, 000
Detroit, Lansing and Northern Railroad	55, 800, 000	158, 200, 000	214, 150, 000
Flint and Pere Marquette Railroad	118, 500, 000	161, 800, 000	146, 100, 000
Grand Rapids and Indiana Railroad	145, 400, 000	224, 650, 000	228, 000, 000
Jackson, Lansing and Saginaw Railroad	7, 500, 000	35, 325, 000	41, 900, 000
Saginaw Valley and Saint Louis and Chicago, Saginaw and Canada Railroads	9, 950, 000	13, 450, 000	12, 710, 000
Green Bay Shore, Wisconsin	26, 300, 000	63, 200, 000	85, 400, 000
Wolf River, Wisconsin	164, 650, 000	150, 225, 000	123, 192, 000
Wisconsin Central Railroad, Wisconsin	22, 000, 000	84, 000, 000	132, 700, 000
Green Bay and Minnesota Railroad, Wisconsin	3, 500, 000	6, 650, 000	10, 700, 000
Black River, Wisconsin	26, 450, 000	35, 800, 000	37, 675, 000
Mississippi River and tributaries	423, 527, 000	504, 278, 000	491, 192, 000
Total	1, 365, 352, 000	2, 043, 378, 000	2, 238, 809, 000

[1] May this not be more probably due to the fact that the bluffs facing the north retain the winter snows, and have their vegetation thus retarded until warm weather is confirmed?—(H.)

General summary of Lumber Manufactures in 1875 *and* 1876 *in the Northwestern States.*

[As published by the *Lumberman's Gazette*, ix, 112.—Mr. C. B. Headley, of East Saginaw, has published annually the statistics of the lumber trade of Saginaw through many years, and is, we believe the person who collected the statistics here given.]

Localities.	Lumber cut.		Lath cut.		Shingles cut.	
	1875.	1876.	1875.	1876.	1875.	1876.
MICHIGAN.						
Saginaw Valley	581, 558, 273	573, 950, 771	71, 509, 225	72, 514, 999	124, 051, 250	135, 429, 750
Alpena	81, 158, 000	85, 346, 927	19, 933, 150	23, 542, 400	44, 906, 000	42, 616, 000
Other Huron shore points	149, 933, 000	165, 850, 000	28, 080, 000	21, 150, 000	72, 050, 000	64, 600, 000
Saint Clair County	29, 000, 000	25, 000, 000	9, 000, 000	8, 000, 000	3, 000, 000	2, 000, 000
Detroit	22, 500, 000	14, 750, 000	6, 125, 000	5, 000, 000	2, 000, 000	1, 000, 000
Lapeer County	45, 550, 000	50, 425, 000	11, 100, 000	11, 900, 000	62, 900, 000	64, 000, 000
Saginaw Valley & Saint Louis Railroad	18, 100, 000	14, 000, 000	1, 700, 000	2, 200, 000	17, 300, 000	15, 000, 000
Jackson, Lansing and Saginaw Railroad	51, 250, 000	49, 890, 000	10, 200, 000	6, 451, 550	22, 587, 500	33, 615, 000
Flint & Pere Marquette Railway to Ludington	93, 995, 846	75, 609, 846	8, 866, 000	9, 298, 000	160, 000, 000	147, 840, 000
Ludington	95, 044, 212	100, 346, 930	5, 430, 100	3, 552, 400	4, 000, 000	8, 000, 000
Manistee	150, 500, 000	145, 750, 000	30, 000, 000	27, 500, 000	148, 500, 000	181, 094, 000
Oceana County	40, 247, 000	32, 093, 000	2, 000, 000	1, 000, 000	44, 505, 000	39, 688, 000
Whitehall	29, 500, 000	36, 000, 000	8, 500, 000	11, 000, 000	13, 000, 000	33, 147, 000
Montague	51, 000, 000	52, 000, 000	6, 000, 000	13, 000, 000	12, 000, 000	13, 000, 000
Muskegon	303, 010, 225	290, 363, 585	80, 058, 400	65, 737, 400	6, 000, 000	10, 000, 000
Grand Rapids	39, 200, 000	39, 575, 147	10, 900, 000	7, 800, 000	4, 500, 000	4, 500, 000
Spring Lake and Grand Haven	100, 500, 000	68, 700, 000	7, 000, 000	8, 850, 000	50, 000, 000	42, 000, 000
Grand Rapids and Indiana Railroad	134, 150, 000	128, 480, 000	13, 600, 000	13, 100, 000	248, 250, 000	266, 500, 000
Grand Rapids and Newaygo Railroad	27, 250, 000	26, 000, 000	4, 000, 000	1, 000, 000	11, 500, 000	16, 500, 000
Detroit and Bay City Railroad	29, 300, 000	19, 700, 000	....	....	18, 200, 000	16, 750, 000
Detroit, Lansing and Lake Michigan Railroad	105, 100, 000	92, 000, 000	13, 450, 000	9, 200, 000	203, 500, 000	206, 200, 000
Menominee	54, 451, 096	70, 438, 316	13, 303, 100	9, 895, 900	26, 000, 000	10, 500, 000
Ford River, Escanaba, &c	21, 300, 000	26, 000, 000	3, 000, 000	3, 500, 000	15, 000, 000	16, 000, 000
Other points reported	88, 206, 000	78, 693, 000	14, 300, 000	13, 500, 000	23, 425, 000	42, 000, 000
Mills not reported; estimated	58, 176, 375	72, 147, 518	23, 000, 000	24, 250, 000	41, 225, 720	72, 095, 250
Total	2, 399, 980, 027	2, 353, 110, 040	401, 054, 975	372, 942, 649	1, 378, 400, 470	1, 484, 075, 000
WISCONSIN.						
Marinette and vicinity	67, 500, 000	98, 511, 000	11, 000, 000	13, 000, 000	7, 000, 000	9, 000, 000
Oconto	60, 000, 000	65, 000, 000	15, 000, 000	17, 000, 000	7, 000, 000	9, 000, 000
Peshtigo	46, 500, 000	48, 896, 000	11, 600, 000	12, 250, 000	9, 000, 000	7, 500. 000
Green Bay	27, 000, 000	28, 000, 000	9, 500, 000	11, 000, 000	90, 000, 000	88, 000, 000
Oshkosh	98, 500, 000	77, 000, 000	7, 000, 000	8, 000, 000	95, 000, 000	80, 000, 000
Oshkosh and vicinity	17, 000, 000	18, 000, 000	1, 500, 000	2, 000, 000	11, 000, 000	13, 000, 000
Fond du Lac	38, 000, 000	35, 000, 000	7, 000, 000	6, 500, 000	25, 000, 000	26, 000, 000
Wausau and vicinity	43, 000, 000	30, 000, 000	6, 500, 000	7, 000, 000	23, 000, 000	24, 000, 000
Stevens Point and vicinity	19, 000, 000	23, 000, 000	4, 000, 000	4, 500, 000	12, 000, 000	15, 000, 000
Black River Falls	19, 000, 000	17, 000. 000	2, 500, 000	3, 000, 000	5, 000, 000	5, 000, 000
Chippewa Falls	35, 000, 000	38, 000, 000	3, 500, 000	4, 000, 000	8, 000, 000	9, 000, 000
Eau Claire	145, 000, 000	32, 250, 000	33, 000, 000	31, 000, 000	40, 000, 000	45, 000, 000
Menomonee	70, 000, 000	72, 000, 000	8, 000, 000	8, 500, 000	25, 000, 000	32, 000, 000
La Cross	58, 000, 000	60, 000, 000	16, 500, 000	17, 000, 000	24, 000, 000	23, 000, 000
Other points; estimated	270, 000, 000	275, 000, 000	38, 000, 000	37, 000, 000	140, 000, 000	150, 000, 000
Total	1, 013, 500, 000	917, 657, 000	174, 600, 000	181, 750, 000	521, 000, 000	535, 500, 000
MINNESOTA.						
Minneapolis	146, 500, 000	197, 111, 000	21, 500, 000	21, 700, 000	84, 500, 000	86, 000, 000
Stillwater	70, 300, 000	67, 704, 000	13, 000, 000	12, 200, 000	40. 800, 000	44, 734, 000
Winona	23, 000, 000	30, 250, 000	7, 000, 000	6, 850, 000	26, 000, 000	21, 500, 000
Other points	135, 000, 000	150, 000, 000	35, 000, 000	40, 000, 000	85, 000, 000	90, 000, 000
Total	374, 800, 000	445, 065, 000	76, 500, 000	80, 750, 000	236, 300, 000	242, 234, 000
MISSISSIPPI RIVER.						
Points above Dubuque	21, 000, 000	21, 800, 000	3, 500, 000	3, 700, 000	8, 500, 000	8, 000, 000
Dubuque	14, 000, 000	20, 400, 000	1, 000, 000	1, 500, 000	9, 000, 000	11, 500, 000
Clinton, Lyons, and Fulton	122, 018, 000	123, 717, 000	18, 054, 600	18, 480, 000	46, 270, 000	45, 000, 000
Rock Island, Davenport, and Moline	74, 550, 000	104, 350, 000	19, 330, 000	21, 740, 000	18, 000, 000	19. 288, 000
Below Davenport	72 875, 000	75, 600, 000	18, 000, 000	19, 900, 000	62, 000, 000	65, 000, 000
Total	304, 443, 000	345, 867, 000	59, 884, 600	65, 320, 000	143, 770, 000	148, 788, 000
General total	4, 092, 723, 027	4, 061. 699, 040	712, 039, 575	701, 763, 649	2, 279, 470, 470	2, 410, 597, 000

Comparative statement of the Lumber Product of Michigan, Wisconsin, and the Upper Mississippi region.

I.—NUMBER OF ESTABLISHMENTS; NUMBER AND KINDS OF SAWS; PERCENTAGE OF PRODUCTION.[1]

Lumber districts and places.	Establishments.	Kinds of saws.				Percentages of production.
		Gang.	Circular.	Muley.	Gang edgers.	
MICHIGAN.						
Eastern shore below Saginaw:						
Detroit	6	3	6	3	6	25.0
Port Huron	6	....	8	2	6	31.0
Port Crescent to Cassville	3	3	3	....	6	44.0
Total	15	6	17	5	18	100.0
Saginaw Valley:						
Saginaw City	14	15	15	4	18	22.5
East Saginaw	24	19	22	12	23	29.0
Bay City, &c	28	25	37	14	4	48.5
Total	66	59	74	30	45	100.0
Eastern shore above Saginaw:						
Alpena	10	8	12	5	15	66.0
Duncan City	1	3	3	....	3	16.0
Cheboygan	3	1	4	....	2	18.0
Total	14	12	19	5	20	100.0
Total eastern shore	95	77	110	40	83	....
Western shore:						
Traverse City	2	2	3	....	3	2.0
Frankfort	4	2	8	....	8	3.9
Manistee	14	1	27	....	23	19.2
Ludington	6	2	12	....	12	13.7
Pentwater	3	....	3	1	4	1.7
Montague	6	2	8	4	9	6.4
Whitehall	5	....	6	....	6	4.1
Muskegon	25	10	38	7	46	39.6
Spring Lake	3	1	6	1	8	3.1
Perrysburg	1	....	2	....	2	0.4
Grand Haven	10	....	11	2	10	4.1
Saugatuck	2	....	2	1	2	1.3
South Haven	1	....	2	....	1	0.5
Total	82	20	128	16	134	100.0
Total both shores (Lower Peninsula)	177	97	238	56	217	....
Railroads:						
Chicago and Michigan Lake Shore	22	2	26	1	19	7.9
Detroit and Bay City, and Chicago and Lake Huron Railroads	23	2	26	2	17	10.2
Detroit and Milwaukee	8	1	9	....	7	3.0
Detroit, Lansing and Northern Railroad (main line)	20	....	22	....	20	18.5
Detroit, Lansing and Northern Railroad (Stanton branch)	25	1	25	....	14	
Flint and Pere Marquette (Flint)	7	1	11	6	9	14.5
Flint and Pere Marquette (other places)	35	....	38	....	23	
Grand Rapids and Indiana (above Grand Rapids)	49	1	52	2	46	25.2
Grand Rapids and Indiana (at Grand Rapids)	9	1	15	1	14	
Grand Rapids, Newaygo and Lake Shore	10	....	34	1	6	2.9
Jackson, Lansing and Saginaw	31	4	32	6	20	16.2
Saginaw Valley and Saint Louis, and Cincinnati, Sandusky and Cleveland Railroads	15	1	15	....	11	1.6
Total railroads	254	14	305	19	206	100.0
Total Lower Peninsula	431	111	543	75	423	....

Comparative statement of the Lumber Product of Michigan, &c.—Continued.

Lumber districts and places.	Establishments.	Kinds of saws.				Percentages of production.
		Gang.	Circular.	Muley.	Gang-edgers.	
MICHIGAN—Continued.						
Upper Peninsula:						
Cedar Fork	1	2	....	1	1	27.9
Ford River	2	1	4	....	4	56.1
Escanaba	1	1	....	2	1	12.4
Masonville	2	....	2	1	2	3.6
Total shore Lake Michigan	6	4	6	4	8	100.0
Menomonee River	9	12	11	1	15	....
Marquette	3	....	3	1	2	82.0
Ishpeming	1	....	1	....	....	18.0
Total Lake Superior shore	4	....	4	1	2	100.0
Total Upper Peninsula	19	16	21	6	25	....
Total Michigan	450	127	564	81	448	....
WISCONSIN.						
Green Bay Shore:						
Peshtigo	1	2	3	....	3	28.3
Oconto	6	6	7	....	12	45.1
Stiles	1	2	1	....	1	....
Pensaukee	1	1	1	....	1	4.3
Big and Little Suamico	3	....	3	....	2	9.0
Depere	5	....	5	....	2	2.7
Green Bay	1	....	1	....	1	....
Little Sturgeon Bay	1	....	2	....	....	6.7
Sturgeon Bay	2	....	3	....	2	3.9
Total	21	11	26	....	24	100.0
Railroads:						
Green Bay and Minnesota	9	....	9	....	6	39.5
Wisconsin Central	16	....	16	....	11	60.5
Total	25	....	25	....	17	100.0
Wolf River:						
Fond du Lac	10	1	14	....	11	20.0
Oshkosh	21	1	21	....	17	55.0
Above Oshkosh	12	2	14	....	9	25.0
Total	43	4	49	....	37	100.0
Saint Croix River:						
Wisconsin side (Hudson)	1	4	13	1	13	9.2
Chippewa River:						
Vanville	1	....	2	1	1	1.0
Chippewa Falls	5	5	7	....	9	17.0
Badger's Mills	1	1	1	....	1	4.0
Eau Claire	11	10	19	....	18	44.0
Meridian	1	....	1	....	1	3.0
Menomonee	1	7	7	....	5	27.0
Downsville	1	1	1	....	2	4.0
Total	21	24	38	1	37	100.0
Black River:						
Black River Falls	3	....	4	....	3	1.8
La Crosse	10	6	16	....	12	98.2
Total	13	6	20	....	15	100.0
Wisconsin River:						
Above Stevens' Point	14	....	16	....	15	44.0
At Stevens' Point	6	....	9	....	7	16.0
Below Stevens' Point	13	1	22	....	13	40.0
Total	33	1	47	....	35	100.0

Comparative statement of the Lumber Product of Michigan, &c.—Continued.

Lumber districts and places.	Establishments.	Kinds of saws.				Percentages of production.
		Gang.	Circular.	Muley.	Gang-edgers.	
WISCONSIN—Continued.						
Mississippi River:						
Alma	2		2		2	62.5
Glen Haven	1		1		1	25.0
Cassville	1		1			12.5
Total	4		4		3	100.0
Total, rivers of Wisconsin	115	39	171	2	140	
Total Wisconsin	161	50	196	2	181	
MINNESOTA.						
Saint Croix River:						
Stillwater	8	4	9	1	10	90.0
Marine Mills	3		3		2	10.0
Total	11	4	12	1	12	100.0
Mississippi River:						
Saint Cloud	3		5		1	4.7
Anoka	1	1	1		1	
Minneapolis	17	19	23		23	78.0
Hastings	2	2	3		3	17.3
Red Wing	2		4		1	
Lake City	1		1			
Winona	2		4		2	
Total	28	22	41		31	100.0
Total Minnesota	39	26	53	1	43	
IOWA.						
Mississippi River:						
Lansing	2		3		2	1.3
McGregor	3	2	3		3	6.0
Guttenberg	1		1		1	0.4
Dubuque	5	1	8	1	5	6.8
Bellevue	1		2		1	0.7
Sabula	1		1		1	0.8
Lyons	3	3	5		5	8.1
Clinton	4	15	8	3	14	32.4
Comanche	1		1	1	1	1.3
Davenport	5	4	7	1	5	17.2
Muscatine	3	2	5		4	11.1
Burlington	2		3		3	4.0
Fort Madison	2		4		2	6.1
Montrose	1		2		1	1.8
Keokuk	1		2		1	2.0
Total	35	27	55	6	49	100.0
ILLINOIS.						
Mississippi River:						
Savanna	1		1	1		1.6
Fulton	2	1	2	1	2	3.3
Albany	1		1		1	5.0
Port Byron	1		1	1		2.0
Rock Island	2	2	5		3	46.7
Moline	2	2	4		3	36.0
Quincy	1		2		1	5.4
Total	10	5	16	3	10	100.0
MISSOURI.						
Mississippi River:						
Hannibal	1	1	2		2	64.0
Louisiana	1		2		1	36.0
Total	2	1	4		3	100.0

Comparative statement of the Lumber Products of Michigan, &c.—Continued.

Lumber districts and places.	Establishments.	Kinds of saws.				Percentages of production.
		Gangs.	Circular.	Muley.	Gang-edgers.	
RECAPITULATION.						
Michigan	450	127	564	81	448	59.3
Wisconsin	161	50	196	2	181	22.0
Minnesota	39	26	53	1	43	8.2
Iowa	35	27	55	6	49	8.0
Illinois	10	5	16	3	10	1.9
Missouri	2	1	4	....	3	0.6
Upper Lakes	208	112	248	61	251	45.5
Rivers	210	110	310	13	260	39.0
Railroads	279	14	330	19	223	15.5
Mississippi River above Iowa line	32	22	45	....	34	40.2
Mississippi River below Iowa line	47	33	75	9	62	59.8
Total Mississippi River	79	55	120	9	96	100.0
Tributaries of Mississippi River:						
Saint Croix	12	8	25	2	25	17.8
Chippewa	21	24	38	1	37	5.0
Black	13	6	20	....	15	6.1
Wisconsin	33	1	47	....	35	9.2
Tributaries to Lake Michigan:						
Menominee	9	12	11	1	15	10.2
Wolf	43	4	49	....	37	9.2
Total rivers	210	110	310	13	260	100.0
General total	710	242	1008	93	749	100.0

II.—CAPACITY, AND FEET OF LUMBER SAWED IN 1874, 1875, AND 1876.

Lumber districts and places.	Season capacity (day sawing).	Lumber manufactured during the season.		
		1874.	1875.	1876.
LOWER MICHIGAN: *Eastern Shore.*				
Detroit	46,000,000	30,000,000	24,000,000	12,200,000
Port Huron	34,000,000	18,600,000	19,800,000	15,500,000
Port Crescent, Port Austin, and Cassville	33,000,000	17,000,000	23,250,000	21,000,000
Total below Saginaw River	113,000,000	65,600,000	67,050,000	48,700,000
Saginaw City	154,500,000	117,826,000	130,472,000	121,321,000
East Saginaw	226,000,000	142,866,000	150,578,267	159,022,000
Bay City, &c	337,500,000	247,376,595	250,383,290	257,008,000
Total Saginaw Valley	718,000,000	508,068,595	531,433,557	537,351,000
Alpena	90,000,000	75,845,000	82,800,000	84,800,000
Duncan City	27,000,000	10,000,000	16,000,000	20,000,000
Cheboygan	24,000,000	19,500,000	13,400,000	23,000,000
Total above Saginaw River	141,000,000	105,345,000	112,200,000	127,800,000
Total eastern shore	972,000,000	679,013,595	710,683,557	713,851,000
LOWER MICHIGAN *Western Shore.*				
Traverse City	22,000,000	11,000,000	19,200,000	15,000,000
Frankfort	46,000,000	21,000,000	26,000,000	29,600,000
Manistee	197,000,000	152,507,864	160,825,855	146,424,296
Ludington	123,000,000	92,225,000	94,800,000	104,723,917
Pentwater	22,000,000	11,500,000	18,450,000	13,100,000
Montague	63,000,000	39,800,000	38,400,000	48,500,000
Whitehall	38,000,000	11,500,000	27,000,000	31,100,000

Comparative statement of the Lumber Products of Michigan, &c.—Continued.

Lumber districts and places.	Season capacity (day sawing).	Lumber manufactured during the season.		
		1874.	1875.	1876.
LOWER MICHIGAN—Contined.				
Muskegon	387, 000, 000	309, 200, 000	345, 400, 000	302, 234, 000
Spring Lake	48, 000, 000	28, 000, 000	30, 500, 000	23, 500, 000
Perrysburg	12, 000, 000	8, 500, 000	9, 000, 000	3, 500, 000
Grand Haven	62, 500, 000	44, 464, 000	48, 600, 000	31, 500, 000
Saugatuck	13, 500, 000	11, 000, 000	17, 000, 000	9, 750, 000
South Haven	6, 000, 000	4, 250, 000	6, 780, 000	3, 500, 000
Total western shore	1, 040, 000, 000	744, 946, 864	841, 955, 855	762, 432, 123
Total both shores Lower Peninsula	2, 012, 000, 000	1, 423, 960, 459	1, 552, 639, 412	1, 476, 283, 123
Lines of railroad.				
Chicago and Michigan Lake Shore Railroad[1]	98, 000, 000	40, 615, 000	59, 700, 000	39, 800, 000
Detroit and Bay City, and Chicago and Lake Huron Railroads[2]	120, 500, 000	48, 500, 000	65, 100, 000	51, 500, 000
Detroit and Milwaukee Railroad[3]	37, 000, 000	17, 000, 000	18, 500, 000	14, 950, 000
Detroit, Lansing, and Lake Michigan Railroad[4]—Main line	109, 500, 000	28, 750, 000	59, 100, 000	51, 250, 000
Stanton branch	104, 000, 000	37, 950, 000	45, 850, 000	42, 350, 000
Flint and Pere Marquette Railroad[5]—Flint	66, 000, 000	50, 275, 000	39, 927, 000	42, 035, 000
Other places	156, 000, 000	39, 200, 000	42, 330, 000	31, 200, 000
Grand Rapids and Indiana Railroad[6]—Above Grand Rapids	230, 100, 000	68, 500, 000	98, 175, 000	90, 250, 000
At Grand Rapids	72, 500, 000	43, 500, 000	49, 650, 000	36, 800, 000
Grand Rapids, Newaygo, and Lake Shore Railroad[7]	34, 000, 000	....	14, 890, 000	14, 850, 000
Jackson, Lansing, and Saginaw Railroad[8]	173, 000, 000	60, 050, 000	90, 750, 000	82, 150, 000
Saginaw Valley and Saint Louis, and Chicago, Saginaw, and Canada Railroads[9]	68, 500, 000	16, 500, 000	16, 100, 000	8, 200, 000
Total railroad lines Michigan	1, 269, 100, 000	450, 840, 000	599, 982, 000	505, 335, 000
Total Lower Peninsula	3, 281, 100, 000	1, 874, 800, 459	2, 152, 621, 412	1, 981, 618, 123
MICHIGAN: *Upper Peninsula.*				
Cedar Fork	10, 000, 000	9, 000, 000	8, 500, 000	9, 500, 000
Ford River	23, 500, 000	18, 225, 000	19, 075, 000	19, 300, 000
Escanaba	5, 500, 000	4, 125, 000	4, 350, 000	4, 250, 000
Masonville	11, 000, 000	225, 000	2, 250, 000	1, 300, 000
Total shore of Lake Michigan	50, 000, 000	31, 575, 000	34, 175, 000	34, 350, 000
Menominee River[10]	161, 500, 000	124, 368, 464	117, 505, 802	141, 985, 870

[1] Along the southwest part of Lower Peninsula, near Lake Michigan, from New Buffalo to Pent Water, 170 miles; with a line from Holland to Grand Rapids, 25 miles, and from Muskegon to Big Rapids, 55 miles; total 250 miles. In the counties of Berrien, Van Buren, Allegan, Ottawa, Kent, Muskegon, Oceana, Newaygo, and Mecosta.

[2] Detroit and Bay City Railroad, operated as a division of the Michigan Central Railroad, and runs from Detroit to Bay City, 123 miles, with a branch from Lapeer to Five Lakes, 6 miles; total, 129 miles Near the eastern border of the State, in the counties of Wayne, Macomb, Oakland, Lapeer, Tuscola, and Saginaw.

The Chicago and Lake Huron Railroad runs from Port Huron to Flint, to Valparaiso, Ind., 281 miles The part embraeing the lumber is toward the eastern end.

[3] Crosses the State from Detroit to Grand Haven, 189 miles, through the counties of Wayne, Oakland, Genesee, Shiawassee, Clinton, Ionia, Kent, and Ottawa. The lumbering included in the table is located in the interior, west of the center.

[4] From Detroit to Howard, 164 miles, and a branch from Ionia to Stanton, 24 miles; total 188 miles. In the counties of Wayne, Washtenaw, Oakland, Livingston, Ingham, Clinton, Ionia, Kent, and Montcalm. The lumber stations are chiefly near the northwestern end, and on the Stanton branch.

[5] From Toledo, Ohio, to Ludington, Mich., 279 miles, with a branch from Flint to Otter Lake, 19 miles, and from East Saginaw to Bay City, 13 miles; total 311 miles. The lumber stations are chiefly at Flint and westward, in the counties of Genesee, Saginaw, Midland, Isabella, Clare, Osceola, Lake, and Mason.

[6] From Grand Rapids, Mich., to Richmond, Ind., 234 miles, and from Grand Rapids to Petoskey, 190 miles; with branch from Walton to Traverse City, 26 miles; total, 450 miles. Lumber stations at and above Grand Rapids.

[7] From Grand Rapids to Big Rapids, 67 miles. In the counties of Kent, Mecosta, and Montcalm.

[8] From Jackson to Bay City, 121 miles. Operated as a division of the Michigan Central Railroad. In the counties of Jackson, Ingham, Clinton, Shiawassee, and Saginaw. Lumber stations northward from Lansing.

[9] Saginaw Valley and Saint Louis Railroad, from Tittabawassee westward to Saint Louis, 28 miles In Saginaw and Gratiot Counties.

Chicago, Saginaw and Canada Railroad, from Saint Louis to Cedar Lake, 20 miles. In Gratiot and Montcalm Counties.

[10] The Menominee River is on the line between Wisconsin and Michigan. As we have no means for locating these mills by States, they are included in Michigan.

Comparative statement of the Lumber Products of Michigan, &c.—Continued.

Lumber districts and places.	Season capacity (day sawing).	Lumber manufactured during the season.		
		1874.	1875.	1876.
MICHIGAN—Continued.				
Marquette	10, 500, 000	3, 500, 000	5, 800, 000	6, 850, 000
Ishpeming	2, 000, 000	1, 000, 000	1, 800, 000	1, 450, 000
Total Lake Superior shore	12, 500, 000	4, 500, 000	7, 600, 000	8, 300, 000
Total Upper Peninsula	224, 000, 000	160, 443, 464	159, 280, 802	184, 635, 870
Total Michigan	3, 505, 100, 000	2, 035, 243, 923	2, 311, 902, 214	2, 166, 253, 993
WISCONSIN.				
Peshtigo	40, 000, 000	34, 300, 000	36, 500, 000	39, 000, 000
Oconto	82, 000, 000	54, 500, 000	58, 000, 000	62, 500, 000
Stiles	8, 000, 000	6, 000, 000	7, 000, 000	....
Pensaukee	8, 000, 000	....	5, 000, 000	6, 000, 000
Big and Little Suamico	23, 000, 000	....	400, 000	12, 500, 000
Depere	15, 500, 000	4, 600, 000	6, 400, 000	3, 750, 000
Green Bay	6, 000, 000	....	6, 000, 000	....
Little Sturgeon Bay	11, 000, 000	....	....	9, 000, 000
Sturgeon Bay	13, 500, 000	10, 000, 000	7, 500, 000	5, 500, 000
Total Green Bay shore	207, 000, 000	109, 400, 000	126, 800, 000	138, 250, 000
Lines of railroad.				
Green Bay and Minnesota Railroad[11]	34, 500, 000	4, 000, 000	6, 600, 000	17, 700, 000
Wisconsin Central Railroad[12]	72, 500, 000	7, 275, 000	23, 100, 000	31, 530, 000
Total of two above-named railroads	107, 000, 000	11, 275, 000	29, 700, 000	49, 230, 000
Rivers.				
Wolf River:				
Fond du Lac	75, 000, 000	50, 435, 000	37, 837, 000	34, 845, 077
Oshkosh	118, 000, 000	93, 150, 000	87, 800, 000	77, 000, 000
Above Oshkosh	65, 500, 000	32, 000, 000	38, 100, 000	26, 800, 000
Total Wolf River	258, 500, 000	175, 585, 000	163, 737, 000	138, 645, 077
Saint Croix (Wisconsin side):				
Hudson	3, 000, 000	2, 000, 000	1, 250, 000	1, 687, 000
Chippewa River:				
Vanville	3, 500, 000	....	....	600, 000
Chippewa Falls	47, 500, 000	52, 500, 000	34, 700, 000	43, 000, 000
Badger's Mills	10, 000, 000	12, 000, 000	10, 000, 000	10, 000, 000
Eau Claire	157, 500, 000	147, 199, 040	130, 377, 000	111, 556, 320
Meridian	8, 000, 000	5, 500, 000	8, 000, 000	8, 710, 679
Menomonee	75, 000, 000	65, 000, 000	69, 000, 000	72, 000, 000
Downsville	9, 500, 000	....	12, 000, 000	10, 000, 000
Total Chippewa River	311, 000, 000	282, 199, 040	264, 077, 000	255, 866, 999
Black River:				
Black River Falls	6, 500, 000	4, 500, 000	4, 000, 000	1, 300, 000
La Crosse	94, 500, 000	58, 750, 000	58, 000, 000	69, 552, 747
Total Black River	101, 000, 000	63, 250, 000	62, 000, 000	70, 852, 747
Wisconsin River:				
Above Stevens' Point	85, 500, 000	21, 600, 000	50, 500, 000	61, 600, 000
At Stevens' Point	39, 500, 000	20, 500, 000	17, 500, 000	22, 300, 000
Below Stevens' Point	97, 000, 000	29, 250, 000	51, 600, 000	55, 800, 000
Total Wisconsin River	222, 000, 000	71, 350, 000	119, 600, 000	139, 700, 000

[11] From Green Bay westward across Wisconsin to the Mississippi, at Bluff Siding, opposite Winona, and to La Crosse, 244 miles. In the counties of Brown, Outagamie, Waupaca, Portage, Wood, Jackson, Trempealeau, Buffalo, and La Crosse.

[12] From Milwaukee to Ashland, on Lake Superior, 351 miles; from Hilbert to Green Bay, 27 miles; and from Stevens Point to Portage, 71 miles; total, 449 miles. In the counties of Milwaukee, Ozaukee, Sheboygan, Calumet, Brown, Winnebago, Outagamie, Waupaca, Portage, Wood, Marathon, Taylor, Chippewa, and Ashland. North of Stevens Point this road has been recently completed through a dense forest, which will hereafter give a very largely increased production. There are at time of writing (September, 1877) about 24 saw-mills on the line of this road. An extended account of the timber-resources of this road will be found in the *Northwestern Lumberman* for September 29, 1877.

Comparative Statement of the Lumber Products of Michigan, &c.—Continued.

Lumber districts and places.	Season capacity (day sawing).	Lumber manufactured during the season.		
		1874.	1875.	1876.
Mississippi River:				
Alma, Buffalo County	7,500,000	....	6,000,000	5,000,000
Glen Haven, Grant County	3,500,000	....	1,500,000	2,000,000
Cassville, Grant County	1,500,000	....	1,500,000	1,000,000
Total Mississippi River	12,500,000	....	9,000,000	8,000,000
Total Rivers Wisconsin	908,000,000	594,384,040	619,664,000	614,751,823
Total Wisconsin	1,223,000,000	715,059,040	776,164,000	802,231,823
MINNESOTA.				
Saint Croix River:				
Stillwater	77,500,000	52,000,000	64,770,000	59,134,000
Marine Mills	11,500,000	6,200,000	9,500,000	5,972,000
Total Saint Croix River	89,000,000	58,200,000	74,270,000	65,106,000
Mississippi River:				
Saint Cloud	14,500,000	....	5,300,000	7,800,000
Anoka	4,500,000	....	3,900,000	4,000,000
Minneapolis	175,000,000	187,303,022	152,269,000	191,950,000
Hastings	15,000,000	8,000,000	7,500,000	7,000,000
Red Wing	12,000,000	7,000,000	11,300,000	10,200,000
Lake City	1,500,000	1,000,000	50,000	350,000
Winona	24,500,000	25,000,000	20,850,000	24,000,000
Total Mississippi River	247,000,000	228,303,022	201,169,000	245,300,000
Total Minnesota	336,000,000	286,503,022	275,439,000	310,406,000
IOWA.				
Mississippi River:				
Lansing	12,500,000	....	4,500,000	3,800,000
McGregor	25,000,000	11,500,000	16,500,000	18,000,000
Guttenberg	2,000,000	....	1,000,000	1,250,000
Dubuque	30,500,000	12,600,000	14,000,000	20,400,000
Bellevue	5,000,000	....	2,250,000	2,250,000
Sabula	3,500,000	2,200,000	2,550,000	2,500,000
Lyons	41,000,000	23,000,000	30,500,000	24,500,000
Clinton	117,000,000	77,165,000	85,218,000	97,217,000
Camanche	6,000,000	4,000,000	5,000,000	4,000,000
Davenport	54,000,000	38,500,000	43,550,000	51,850,000
Muscatine	41,000,000	37,000,000	38,000,000	33,500,000
Burlington	15,000,000	8,600,000	11,875,000	12,090,000
Fort Madison	20,000,000	14,000,000	11,500,000	18,500,000
Montrose	8,000,000	2,000,000	4,500,000	5,500,000
Keokuk	10,000,000	6,000,000	7,000,000	6,100,000
Total Iowa	390,500,000	236,565,000	277,943,000	301,367,000
ILLINOIS.				
Mississippi River:				
Savannah	2,500,000	....	1,485,000	1,000,000
Fulton	17,500,000	5,400,000	6,300,000	2,000,000
Albany	3,000,000	....	2,500,000	3,000,000
Port Byron	3,500,000	....	1,800,000	1,400,000
Rock Island	35,000,000	16,000,000	27,000,000	29,500,000
Moline	25,000,000	19,925,000	14,000,000	23,090,000
Quincy	8,000,000	....	3,500,000	3,200,000
Total Illinois	94,500,000	41,325,000	56,585,000	63,100,000
MISSOURI.				
Mississippi River:				
Hannibal	12,000,000	6,000,000	7,000,000	8,000,000
Louisiana	7,000,000	....	4,000,000	4,600,000
Total Missouri	19,000,000	6,000,000	11,000,000	12,600,000
RECAPITULATION.				
Michigan	3,505,100,000	2,035,243,923	2,311,902,214	2,166,253,993
Wisconsin	1,223,000,000	715,059,040	776,164,000	802,231,823

Comparative statement of the Lumber Products of Michigan, &c.—Continued.

Lumber districts and places.	Season capacity (day sawing).	Lumber manufactured during the season.		
		1874.	1875.	1876.
Minnesota	336, 000, 000	286, 503, 022	275, 439, 000	310, 406, 000
Iowa	390, 500, 000	236, 565, 000	277, 943, 000	301, 367, 000
Illinois	94, 500, 000	41, 325, 000	56, 585, 000	63, 100, 000
Missouri	19, 000, 000	6, 000, 000	11, 000, 000	12, 600, 000
Upper Lakes	2, 281, 500, 000	1, 569, 435, 459	1, 721, 214, 412	1, 657, 183, 123
Rivers	1, 919, 500, 000	1, 289, 145, 526	1, 358, 136, 802	1, 435, 210, 693
Railroads	1, 376, 100, 000	462, 115, 000	629, 682, 000	554, 565, 000
Mississippi River (above Iowa line)	259, 500, 000	228, 303, 022	210, 169, 000	253, 300, 000
Mississippi River (below north line of Iowa)	504, 000, 000	283, 890, 000	345, 528, 000	377, 067, 000
Total Mississippi	763, 500, 000	512, 193, 022	555, 697, 000	630, 367, 000
Total Mississippi and tributaries	1, 489, 500, 000	989, 192, 062	1, 076, 894, 000	1, 154, 579, 746
General total	5, 568, 100, 000	3, 320, 695, 985	3, 709, 033, 214	3, 655, 958, 816

Production of 1877, *at some of the principal lumber-manufacturing places upon the Mississippi River and its tributaries and the Green Bay Shore, etc.*

[From the *Northwestern Lumberman*, January 26, 1878.]

Places.	Establishments.	Saws.				Season capacity (day sawing).	Lumber manufactured in 1877.
		Gang.	Circular.	Muley.	Gang edge.		
MISSISSIPPI RIVER AND TRIBUTARIES.							
Above Minneapolis:							
Saint Cloud, Minn	3	......	5	......	1	14, 500, 000	12, 100, 000
Anoka, Minn	2	1	3	......	3	19, 500, 000	17, 559, 682
At Minneapolis, Minn	16	18	21	......	21	160, 000, 000	111, 215, 402
Below Minneapolis:							
Hastings, Minn	2	2	3	......	3	15, 000, 000	8, 000, 000
Red Wing, Minn	2	......	4	......	1	12, 000, 000	10, 750, 000
Lake City, Minn	1	......	1	......	......	1, 500, 000	800, 000
Alma, Wis	2	......	2	......	2	7, 500, 000	2, 000, 000
Winona, Minn	2	......	4	......	2	24, 500, 000	19, 700, 000
Total for Upper Mississippi	30	21	43	......	33	254, 500, 000	182, 125, 084
Above Dubuque:							
Lansing, Iowa	2	......	3	......	2	12, 500, 000	3, 075, 000
McGregor, Iowa	1	1	1	......	1	15, 000, 000	10, 180, 000
Prairie du Chien, Wis	2	1	2	......	2	10, 000, 000	5, 800, 000
Glen Haven, Wis	1	......	1	......	1	3, 500, 000	....
Guttenburg, Iowa	1	......	1	......	......	2, 000, 000	1, 000, 000
Cassville, Wis	1	......	1	......	......	1, 500, 000	1, 000, 000
At Dubuque, Iowa	5	1	8	1	5	30, 500, 000	21, 250, 000
Bellevue, Iowa	1	......	2	......	1	5, 000, 000	1, 500, 000
Savanna, Ill	1	......	1	1	......	2, 500, 000	....
Sabula, Iowa	1	......	1	......	1	3, 500, 000	1, 300, 000
Lyons, Iowa	3	3	5	......	5	41, 000, 000	19, 600, 000
Clinton, Iowa	4	13	8	2	13	113, 000, 000	57, 796, 567
Fulton, Ill	2	1	2	1	2	17, 500, 000	3, 596, 708
Comanche, Iowa	1	......	1	1	1	6, 000, 000	1, 700, 000
Albany, Ill	1	......	1	......	1	3, 000, 000	2, 000, 000
Port Byron, Ill	1	......	1	1	......	3, 500, 000	1, 000, 000
Davenport, Iowa	5	4	7	1	5	54, 000, 000	41, 965, 185
Rock Island, Ill	2	2	5	......	3	35, 000, 000	21, 600, 000
Moline, Ill	2	2	4	......	2	25, 000, 000	17, 000, 000
Muscatine, Iowa	3	2	5	......	4	41, 000, 000	25, 400, 000
Burlington, Iowa	2	......	3	......	3	15, 000, 000	1, 250, 000
Fort Madison, Iowa	2	......	4	......	2	20, 000, 000	17, 000, 000
Montrose, Iowa	1	......	2	......	1	8, 000, 000	3, 398, 880
Keokuk, Iowa	1	......	2	......	1	10, 000, 000	4, 750, 000
Quincy, Ill	1	......	2	......	1	8, 000, 000	3, 253, 000

Production of 1877, *&c.*—Continued.

Places.	Establishments.	Saws. Gang.	Saws. Circular.	Saws. Muley.	Saws. Gang edge.	Season capacity (day sawings).	Lumber manufactured in 1877.
At Hannibal, Mo	1	1	2	......	2	12, 000, 000	7, 500, 000
Louisiana, Mo	1	......	2	......	1	7, 000, 000	3, 800, 000
Total for main river	79	52	120	8	93	759, 500, 000	959, 840, 424
SAINT CROIX RIVER.							
Stillwater, Minn	12	4	13	1	13	92, 000, 000	53, 341, 030
CHIPPEWA RIVER.							
Vanville, Wis	1	......	2	1	1	3, 500, 000	500, 000
Chippewa Falls, Wis	5	5	7	......	9	47, 500, 000	17, 450, 000
Badger's Mills, Wis	1	1	1	......	1	10, 000, 000	4, 000, 000
Eau Claire, Wis	11	10	19	......	18	157, 500, 000	65, 175, 270
Meridian, Wis	1	......	1	......	1	8, 000, 000	5, 000, 000
Menomonee, Wis	1	8	8	......	7	84, 500, 000	64, 921, 408
Total for Chippewa River	20	24	38	1	37	311, 000, 000	157, 046, 678
BLACK RIVER.							
La Crosse, Wis	10	6	16	......	12	94, 500, 000	44, 650, 000
Black River Falls, Wis	3	......	4	......	3	6, 500, 000	4, 600, 000
Total for Black River	13	6	20	......	15	101, 000, 000	49, 250, 000
WISCONSIN RIVER, WIS.							
Above Stevens Point	19	......	20	......	20	99, 500, 000	57, 670, 000
At Stevens Point	6	......	8	......	7	39, 500, 000	15, 753, 000
Below Stevens Point	17	1	24	......	15	107, 000, 000	50, 500, 000
Wisconsin Valley Railroad, &c	11	......	11	......	8	34, 000, 000	19, 600, 000
Total for Wisconsin River Valley	53	1	63	......	50	280, 000, 000	143, 523, 000
Total Mississippi River and tributaries	177	87	254	10	208	1, 543, 500, 000	863, 001, 132
GREEN BAY SHORE.							
Above Menominee:							
Masonville, Mich	1	......	1	......	1	5, 000, 000	1, 200, 000
Escanaba, Mich	1	1	......	2	1	5, 500, 000	1, 396, 207
Ford River, Mich	1	1	3	......	3	21, 000, 000	11, 500, 000
Cedar Fork, Mich	1	2	......	1	1	10, 000, 000	5, 000, 000
Total above Menominee, Mich	4	4	4	3	6	41, 500, 000	19, 096, 207
Menominee River:							
Menominee, Wis	8	10	10	1	13	141, 500, 000	125, 500, 000
Marinette, Wis	1	2	1	......	2	20, 000, 000	17, 557, 000
Total	9	12	11	1	15	161, 500, 000	143, 057, 000
Below Menominee:							
Peshtigo, Wis	1	2	3	......	3	40, 000, 000	35, 826, 287
Oconto, Wis	6	6	7	......	12	82, 000, 000	37, 300, 000
Stiles, Wis	1	2	1	......	1	8, 000, 000	....
Pensaukee, Wis	1	1	1	......	1	8, 000, 000	4, 900, 000
Suamico, Wis	2	......	2	......	1	15, 000, 000	6, 500, 000
Big Suamico, Wis	1	......	1	......	1	8, 000, 000	6, 500, 000
Green Bay, Wis	1	......	1	......	1	6, 000, 000	7, 000, 000
Depere, Wis	5	......	5	......	2	15, 500, 000	1, 700, 000
Sturgeon Bay, Wis	2	......	3	......	2	13, 500, 000	10, 000, 000
Total below Menominee	20	11	24	......	24	196, 000, 000	109, 726, 287
Total Green Bay shore	33	27	39	4	45	399, 000, 000	271, 879, 494
GREEN BAY AND MINNESOTA RAILROAD.							
Various interior mills, Wisconsin	9	......	9	......	6	34, 500, 000	18, 100, 000
General total of foregoing	219	114	302	14	259	1, 977, 000, 000	1,152, 980, 626

The *Northwestern Lumberman*, of March 30, 1878, contains elaborate statements of the production for 1877, as compared with previous years, but our space will not allow of their insertion.

The construction of short lines of railway, designed for only temporary use, and chiefly or solely for the bringing of logs to floatable streams, or to mills for sawing, has, in recent years, become quite common in the great lumber regions. About a dozen such roads, averaging six or seven miles in length, and some of them with narrow gauge, are now in use or under construction in Michigan. The extreme disappointment and, in many cases, heavy loss occasioned by the want of sufficient snow for logging in the winter of 1877–'78 will tend to increase a desire for a more certain and controllable means for regulating the supply. It is claimed that in many cases the cost of hauling by steam-power is cheaper than by teams.

Portable railroads of narrow gauge, easily laid down and taken up, are used in some countries. They are commonly operated by horse-power, and are found economical and effectual both for drawing fire-wood or long timber. In the latter case two small trucks are used, as far apart as may be convenient.[1]

IOWA.

This is essentially a *prairie State*, its originally timbered portions being chiefly limited to the margins of the smaller streams, and to broader belts along the larger rivers. Wherever there were bottom-lands, with a sufficient amount of moisture assured, by running or standing water, there were trees.

The native timber flora of this State is mentioned in a comparative table, given in our account of Nebraska, showing how these States resemble or differ in regard to their native timber growths.

The greatest interest has been taken in Iowa in regard to timber-planting, through its State and local agricultural and horticultural societies. These, from an early period of their operation, have devoted much attention to the subject in their discussions, and have given place to many articles in their published transactions. These proceedings, and to some extent their results, will be stated in the following pages.

In this State, as in others of the prairie region, the timber question arises in the beginning of settlement, and the want of timber products being among the very first that is felt by the emigrant, his attention is naturally directed at once to the subject of supply. The timber belts along water courses were in very many cases exhausted in the early years of settlement, and supplies of lumber have been brought in later years from regions further east by railroads. But neither of these sources of supply are sure of indefinite continuance, and a prudent foresight has, for many years, led careful land-owners to take measures tending to render themselves independent in regard to wood for fuel and farm purposes, in doing which they at the same time enhance the probabilities of success in agriculture, by acquiring the protection needed by cattle and crops.

The standing committee on forestry of the Iowa Horticultural Society, in January, 1872,[2] referring to the climate as it was when settlements

[1] Perhaps the cheapest and simples contrivance in the way of a tram-road for lumber purposes, on hard, level ground, is the one in which the rails are simply spruce on tamarack poles, kept in place by stakes on pins, and without cross-ties. The wheels of the trucks have concave grooves, large enough to fit upon the poles and keep their places, with sufficient allowance for difference of size. They are used satisfactorily in some parts of the lumber regions of the Northwest.

[2] *Horticultural Report*, 1872, p. 133.

began, and as it is, bear witness to the fact, which they declare to be within the knowledge of all old residents,—that a marked change for the worse has taken place within the last twenty years. The rank verdure of the native prairies, has been succeeded by cultivated fields; ponds and marshes are now dry, and the exposure of the soil to the atmosphere tends to promote evaporation to a degree unknown in the early days of settlement. The only remedy against this great and increasing evil is tree-planting and wind-breaks. Convinced of this, they proceeded to specify the kinds of timber best adapted for cultivation, and the profits from each, being substantially the same given elsewhere in this report, as the authorized instructions of the society, for the cultivation of timber trees.

Prof. C. E. Bessey, of the Iowa Agricultural College, in remarking upon the climate of Iowa, says:

> Our climate is a dry one, subject to great and sudden changes of temperature. These characteristics of climate have much to do with the modifications which every botanist notices in the plants of the Northwest. Our plants, in general, are rougher, harsher, harder, and possessed of more leaf-surface than their relatives in moister and less changeable climates. What these climatic and other conditions have done for the native plants they will do for the introduced ones, and if any particular one differs too much from the typical Northwestern plant, or for some reason cannot undergo the modifications which the aforesaid conditions tend to bring about, then that plant will die. These influences of climate are well known to the botanist and zoölogist, and there can be no reasonable doubt as to their potency. There is but little doubt that one great and preponderating reason why the ordinary Eastern evergreens cannot be made to survive when planted on our open prairies, is to be found in the fact that they are natives of moister and milder climates. The same may be said for the apple.

Alluding to the fact that representative or corresponding species may sometimes be introduced where their native conditions are similar, he suggests that evergreens from the dry, changeable climate of the Rocky Mountains would succeed better than those from the East, and that the native deciduous trees would, in the long run, be found better than those sent from other sections. In the discussions that followed, several speakers dissented, especially in regard to the reliability of Rocky Mountain evergreens and the Norway spruce.

A committee of the State Agricultural Society, in 1866, issued circulars for the purpose of procuring information upon tree-culture, and published returns from over thirty counties, with details of methods and results. Opinions differed somewhat as to kinds that should have preference, mode of planting, &c., but the following were very generally mentioned as adapted to the soil and climate: Cottonwood (got with roots from sand-bars in rivers, or set from cuttings of last year's growth), soft maple, white and black walnut, ash, cherry, and locust; although in some counties the latter had been given up on account of the borers. Of evergreens a confidence was generally expressed in the red cedar, balsam fir, and Norway spruce, and so far as trial had been made, the larch succeeded admirably. The soft maple, cut in June, and peeled, had been found a good fencing material. Cherry posts, well-seasoned before setting, had been found almost as durable as white oak. There was no difference of opinion expressed about the necessity of thorough preparation of the soil and cultivation two or three years to keep down weeds and grass. The majority had selected two or three trees of native species, after trying several. The nut-trees had been found uncertain in transplanting, and should be planted where they should stand. Quite a number planted corn with the trees, the benefits being economy, shelter from the young plants in summer, and support against snows in winter. Profits began to be realized from plantations

in eight or ten years, and a grove of ten acres kept inclosed, would in ten years and afterward, keep a family supplied with fuel permanently.

The cottonwood, poplars, and willows had been planted satisfactorily for fences. The great value of white ash timber and the facility with which it could be cultivated was especially noticed by several. An opinion unfavorable to trimming was expressed by most who preferred leaving the operation to nature. They would generally plant close in the rows, thinning out from time to time as the trees became larger.

A correspondent in Webster County, with the view of testing the qualities of different kinds of timber for live fences, set, in 1863, about twenty rods of each of the following, viz: Cottonwood, Lombardy poplar, silver maple, balm of Gilead, and three kinds of willow, in rows 9 inches between plants, and sowed some locust-seed. The first season the cottonwood grew 7 feet, the poplars 4, the maple and balm 3, the white willow 3½, and other willows 2; while the locust was still less. The next spring he cut down the cottonwood to 3½ feet, and the second season they were 12 to 15 feet high. The growth of timber was in about the same proportion as before. In the third spring he transplanted several of each variety, and found that they grew much faster when not crowded together. The growth of all left in the rows was quite small, except the white willows. The cottonwoods did not grow 6 inches, which proves that they will not bear crowding. His experiment showed that the white willow was the only kind that would grow close together. Having settled these facts, he set, in the spring of 1865, 700 rods of live fence, and the growth in 1866 was 15 feet, and perfectly uniform. He did not prune. A grove of cottonwood and Lombardy poplar set in the spring of 1866 was, by the middle of September of the first year, on an average, 4 feet high, and some of it six.

The Iowa State Agricultural Society, in 1870, offered a premium of $1,000, to be paid in 1881, for the best 10 acres of artificial timber. In 1875 it was stated that four competitors had entered, and annual reports are made showing management and condition.

Efforts were made, in 1871, to learn how much planting had been done in Iowa under the act for encouraging the growth of timber, but with little result. The law was either not known or not regarded as an inducement to planting. One person in Appanoose County had planted 30,000, and another in Lyon County 250,000.

An act for the encouragement of horticulture and forestry, approved April 6, 1872, in granting $1,000 annually to the State Horticultural Society, required that $200 of this sum should be awarded in premiums for the growing of forest trees in the State.

In 1873 twenty-one premiums were offered for the planting of trees and tree seeds in permanent timber plantations or belts, the number of trees living to be ascertained by actual count at the end of the next October. It does not appear that any awards were made upon them. In 1874, and annually since, the society has offered eighteen premiums for forest-tree planting—three each for the following classes, viz:—all species, greatest number in groves;—evergreens and larch in plantations or belts;—ash trees;—nut-bearing trees, including oaks;—black wild cherry, elm, maple, box-elder, and birch; and cottonwood, basswood, willow, poplar, and other soft wood trees. The regulations afford suggestions as to methods, and were as follows:

1. Persons competing for premiums must designate the class for which they compete as for greatest number soft wooded trees, greatest number of evergreens and larch, &c. A plantation may consist of a single variety enumerated in class, or all the kinds mentioned.

2. Additional plantations must be made for each separate entry for premiums. In other words, a person awarded a premium in one class will not be entitled to a premium on the same trees in another class.

3. The plantations competing for these premiums must be made with rooted seedlings or plants, with the exceptions here mentioned. Of willows and soft-wooded trees, growing readily from cuttings, strong cuttings may be used. Also, in the class of nut-bearing trees, white walnut and black walnut may be started where wanted from seeds.

4. All tree-seeds and cuttings must be planted in permanent timber plantations or belts in the spring of 1875. The plantations must not be made at a greater distance than four feet each way, and, when counted, there must be at least 2,300 trees to each acre. The plantations competing for a premium must be on one farm, but need not be contiguous.

5. The competitor must count his trees in the presence of the witnesses between the 1st and 15th days of October, 1875, counting only those which are alive at that time. After counting, competitor must make affidavit before a justice of the peace or notary public as to the following facts:

(A.) Whole number of trees in permanent grove, planted in spring of 1875, and now alive. (B.) Name and number of each kind planted. (C.) How planted. (D.) How cultivated. (E.) Cost of plantation. (F.) Average size of each species of trees.

An affidavit shall be made by both witnesses of the counting, and the officer who administers the affidavit shall certify to the identity and credibility of the competitor and his witnesses.

6. The affidavit prescribed above to be forwarded to the secretary of the State Horticultural Society, Joseph L. Budd, Shellsburg, Benton County, not later than December 1.

7. Premiums will be awarded at the next meeting of the society, at the City of Des Moines, on the third Tuesday in January.[1]

The growing of forest trees from cuttings in Iowa.

Mr. J. L. Budd, now of the Iowa State Agricultural College, furnished for the State Horticultural Report of 1868, p. 111, an article upon this subject, from which we condense the following:

The red maple (*Acer rubrum*), silver maple (*A. dasycarpum*), ash-leaved maple (*Negundo aceroides*), cottonwoods (*Populus monilifera* and *angulata*), balm of Gilead (*P. balsamifera*), Lombardy poplar (*P. dilatata*), white poplar (*P. alba*), sycamore (*Platanus occidentalis*), and white willow (*Salix alba*), will grow from cuttings, and all thrive on the Western prairies. They should be cut early in winter, before severe freezing, in lengths of about one foot. They should be chosen from three-fourths of an inch to an inch and a half in diameter, and the lower end with a clean cut, without bruising or mashing. Of maples the two-year-old wood is best; of the other kinds it makes but little difference, if the growth is free and healthy. Tie in bundles with willows, the lower end nicely evened so that when placed on the ground in spring every piece will touch the moist earth. Pack the bundles in a dry-goods box with moist prairie soil, putting the box where it will not get too dry or wet, and will not freeze. With the first warm weather of spring clean off a spot under an old hay-stack, level the surface carefully, and set the bundles, butt-end down, closely together, upon the fresh moist earth; then cover them with straw so as to keep them from the air. By the time the ground gets warm enough to plant, the base of the cuttings will be softened, and most of them will have emitted small roots.

Plant to the west and north of buildings, but do not plant too close. This is the grand fault with beginners. Make the tract for yards, orchards, gardens, &c., plenty large enough. Mark out the ground one way three feet apart. Plant alternately a row of small growing

---

[1] One award was made in January, 1876, to Lawrie Tatem, of Cedar County. This plantation consisted of 1,448 ash (of which 52 died); 337 European larch (42 died); 306 Austrian pine (56 died); 274 white pines (70 died); 387 Scotch pines (19 died); and 256 Norway spruce (14 died).

corn with a row of cuttings, putting the latter six inches apart at an angle of 45°, using a clean, narrow spade, and press the earth firmly down with the foot. Cuttings should be put down nearly the whole length. When they start allow only one sprout to grow. Cultivate carefully. The alternate row of corn will nearly pay for the culture, and the following winter the stalks will help to hold the snow among the trees. It can be seen the next spring how the plants stand in the rows. If the cuttings are prepared, kept, and set rightly, nearly all will grow, and the plants taken out can be kept and set in other ground. Allow the plants to stand about three feet apart. If many have failed transplant others to their places. As a rule it is better not to transplant. The plantation should be carefully cultivated the next three summers, after which the trees will require no care.

In a paper read by Prof. H. H. McAfee before the American Forestry Association at Philadelphia in September, 1876, he mentioned the following species of deciduous trees (all but the Tyrolese larch being native), which he regarded as of proven value in Iowa, and for cheapness, certainty of growth and value, to be taken in the following order: Black walnut, green ash, box-elder, black cherry, honey-locust, hickory-elm, Tyrolese larch, two-colored oak (*Quercus bicolor*) red elm, red oak, black birch. In the order of abundance planted they were, silver-leaf maple, white willow, cottonwood, box-elder, green ash, and Tyrolese larch. Of evergreens, none had done better than white pine planted among deciduous kinds. The following measurements were shown by seasoned specimens exhibited at the Centennial from Iowa:

Growth of Iowa woods.

Species.	Age (years).	Average annual rate of gain in diameter.	Diameter.	Species.	Age (years).	Average annual rate of gain in diameter.	Diameter.
		Inches.	*Inches.*			*Inches.*	*Inches.*
Acer dasycarpum[1]	9	0.97	8.75	Pinus resinosa[5]	13	0.54	7.00
Negundo aceroides[1]	9	1.00	9.00	Pyrus Americana[5]	17	0.34	5.87
Larix Europaea[1]	9	0.46	4.13	Populus alba[6]	6	1.48	8.88
Ulmus Americana[1]	9	0.62	5.62	Shepardia argentea[6]	12	0.38	4.62
	9	0.48	4.38	Populus alba[7]	22	1.28	28.50
Salix alba[1]	9	1.20	10.87	dilalata[7]	10	1.67	19.75
Castanea vesca[2]	12	0.74	8.88	Pinus resinosa[1]	19	0.56	10.63
Juniperus Virginiana[3]	24	0.34	9.25	Pyrus malus[8]	33	0.54	17.88
Juglans nigra[4]	9	0.59	5.37	communis[9]	9	0.60	5.50
Maclura aurantiaca[5]	19	0.38	7.25				

[1]Iowa Agricultural College. [2]Mrs. Simpson. [3]Mr. Cunningham. [4]C. E. Whiting. [5]G. B. Brackett. [6]H. C. Raymond. [7]G. Wood. [8]Henry Avery. [9]David Leonard.

He had found growing native within the State, 166 species of trees, shrubs, and woody vines, 97 of which grew to 4 inches in diameter and over, and 58 that grew to a foot or more. The largest seen was a yellow cottonwood 6½ feet across at the stump, and furnishing a log 40 feet long, scaling over 8,000 feet of lumber. He recommended planting belts on the south, west, and north sides. It was particularly necessary to shelter trees against the drying southwest winds, which were quite as injurious as those from the northwest, being warmer and more exhausting.

Encouragement of forestry by the Iowa State Horticultural Society.

This society, in 1872, began to offer premiums to encourage tree-planting, and it has for the last four years printed annually, for gratuitous distribution among planters, a pamphlet[1] containing instructions for procuring, storing, and planting of seeds, cuttings, and plants, with hints on best species and varieties, modes of culture, &c., for artificial forests and shelter-belts in that State.

The importance of this subject has been also frequently discussed for many years, as well in the public journals as by speakers at agricultural and horticultural fairs, so that it may be truly said of Iowa that no State in the Union has so generally been awakened to the importance of tree planting. In fact, the great prairies needed no argument to prove the desirability of planting, as well for fences and fuel as for shelter and ornament. The statistical result of these labors will be found on another page in this volume. Some of the practical suggestions of the Annual, which appear to be of more general interest, are here given:

Shelter-belts.

These are wind-breaks for the shelter of domestic animals and crops, and their advantages are set forth by Judge C. E. Whiting, one of the committee charged with the preparation of the Annual, from his own experience (perhaps the most extensive of any person in the country in this branch of forestry) as follows:

"I have, in belts around my fields, varying from single to twenty rows of trees, mostly planted 4,356 to the acre, about 40 acres of timber. The trees in these belts vary as to time of planting; some are eighteen years old and some only one year planted; the greater portion, however, are from five to twelve years of age. The needed thinning of these belts furnishes all the wood that is wanted on the farm, including stakes and rails to keep the fences in repair, posts for all repairs needed, and many for new fences I annually build in extending my farm. When my walnuts get a little larger I will have all I need and many for sale. There is not a stick of needed timber on the farm, from a pea-brush, a grapevine-stake, or a binding-pole, up to a fair-sized saw-log, that cannot be had from my groves, without cutting a single tree that does not need thinning out from the groves.

"About five miles of my timber belts are so planted that I have commenced using the standing trees for fence-posts. Where a tight fence is not needed, with the use of the barbed wire, and a little change in the staple, the use of these live posts is a perfect success. Strongly and urgently as I have heretofore advocated the planting of thick belts of timber around our fields, each year but confirms me in the opinions then expressed. The land that remains will, year after year, produce larger and more certain crops than the whole field would produce without such protection. I also repeat that, in spite of all the learned discussions and scientific theorizing in regard to the cause of our timberless prairies, our cultivated forest trees, year after year, grow right along, with immense rapidity, in blissful ignorance of all the reasons *why they should not grow.*"

The species of trees used in shelter-belts, either on the farm boundaries to the north and west, or to the north and west of dwelling, barns, orchard, garden, &c., will depend greatly on the position of the homestead as to soil and location in the State. The settler absolutely without tree-shelter wishes naturally to reach results as quickly as possible. Fortunately, the willow, the cottonwood, the silver poplar, and the box-elder are all very easy to propagate; as noted in speaking of varieties, are all wonderfully rapid in growth under good cultivation, and, above all, are perfectly hardy, even in the northwestern part of the State. Taking all things into consideration, it is best to put these rampant growers on the outside of belts, adding from year to year the varieties like elm, ash, black cherry, honey-locust, the evergreens, &c., as time and means permit, inside of the iron-clad vanguards placed on the outside. The rapid-growing soft woods, starting readily from cuttings, are the most available for urgent present needs, and the novice in tree-planting is more certain of success with them in his first efforts than with rooted plants of the slower-growing but more valuable timbers. Besides, cuttings cost nothing usually, and are readily obtainable. We append notes on managing cuttings in this connection, as these trees are most frequently used in shelter-belt plantations.

---

[1] *Forestry Annual of the Iowa Horticultural Society.* Four numbers of this have been published, beginning in 1874. The pamphlet for 1877 embraces 24 pages.

How to prepare cuttings.—Very early in winter, before severe freezing, cut in lengths of about a foot. If the limbs to cut are plenty, choose them from three-fourths to one and a half inches in diameter. Cut them at the lower end with a clean cut, sloping at an acute angle, to facilitate pressing in the earth when planting. If sharpened on all sides, as is frequently done, roots are emitted less freely from the lower end. Tie in bundles with willows, with the lower ends nicely evened, so that when placed on the ground in the spring every cutting will touch the moist earth. Pack the cuttings in a dry-goods box, with moist prairie soil, putting the box where it will not get too dry or wet, and will not freeze. With the first warm weather of spring, clean off a spot under an old straw-stack, level the surface carefully, and set the bundles butt-end down closely together upon the fresh, moist earth; then cover them over with straw, so as to keep them from the air. By the time the ground gets warm enough to plant the base of the cuttings will be softened and calloused, and most of them will have emitted small roots.

Mark out your ground one way three feet apart. Plant alternately a row of small growing corn with a row of cuttings. Put the cuttings in rows six inches apart, at an angle of forty-five degrees, using a clean, narrow spade, and press the earth down firmly with the foot. Cuttings should be put down about the whole length. When they start, allow only one sprout to grow. Cultivate carefully. The alternate row of corn will nearly pay for the culture, and the following winter the stalks will help to hold the snow among the trees. The following spring it can be seen how the plants stand in the rows. If the cuttings are prepared, kept, and set right, nearly all will grow, and the surplus plants can be taken up and set in other ground. Allow the plants to stand about three feet apart. If many have failed, transplant so they will set right. As a rule, it is not best to transplant. A tree six years old and never transplanted is usually much the largest.

We may here remark that, in addition to the willows, the white and yellow cottonwood, Lombardy poplar, large aspen, silver poplar, and balm of Gilead may all be propagated in this way, as noted in speaking of varieties. The instructions for managing cuttings will, however, not be repeated.

We may here also note that the red maple, white maple, ash-leaved maple, and basswood may be propagated readily from two-year-old wood, put out in the fall. Cover lightly over the rows, before cold weather, with straw or prairie hay. Rake this off as the plants start in spring.

Evergreens for shelter-belts.—In Eastern Iowa, nearly all of the hardy evergreens may be grown successfully, and form, beyond all doubt, the most perfect shelter-belts that can be planted. But in the central and western portions of the State, north of the forty-second parallel, evergreens even of the hardiest type need shelter; yet this is no reason why they should be ignored in the perfecting of shelter-belts. For reasons before noted, the rapid-growing soft woods are best for outside planting, and are just what is needed to give requisite exemption from wind-sweep to belts of pines or spruces planted under their lee.

For the portions of the State most in need of shelter-belts, the Scotch pine is, beyond all doubt, the best evergreen for this use in the whole list. We can fully indorse the statement of Prof. C. S. Sargent, who says:

"The rapidity of its growth in all situations, and its economic value, make the Scotch pine the most valuable tree farmers can plant for screens and wind-breaks about their fields and buildings, and for this purpose it is recommended in place of the more generally planted Norway spruce, which, though of rapid growth in its young state, does not promise, in our climate at least, to fulfill the hopes which were formed in regard to it."

This pine is specially partial to free circulation of air, growing quite feebly in crowded positions; hence it will not do to plant it as closely as white pine, although, as with other trees, it is best to plant with a view of thinning out when the poles are of size to be of practical use. We may here remark that the poles of Scotch and white pine, cut in summer and stripped of bark, are very strong and durable when nailed on posts for fencing.

The white pine will succeed vastly better with outside shelter on west and north exposures, and will attain height fully as fast as the Scotch pine. Plant in rows eight feet apart, with plants four feet apart. The trees thus crowded will attain height rapidly, and when the poles attain size for nailing on fence-posts, they will be straight and nearly uniform in size from end to end.

The Norway or white spruce, coming next, may be planted the same as Scotch pine. The white spruce is perhaps the most compact and beautiful, but the Norway is the most rapid in growth, and is the most plentiful in the nurseries.

Evergreens twelve to eighteen inches, of all the sorts here named, may be obtained of leading nurserymen, who make seedlings a specialty, at very low rates. Taking into account the first cost of plant, the loss from shipping, dying out, &c., the chances for success, with the ordinary farmer, are too doubtful, except on a small scale, for the shelter of home buildings, where the addition to the landscape view, summer and

winter, will well repay the cost of purchase and after care, saying nothing of their perfect effectiveness in arresting wind and storm. The deciduous trees, such as we specify as valuable for farm uses, are good enough for shelter-belts, and the annual thinings are far more valuable for varied uses. Our main idea, under the heading of shelter-belts, is to recommend strongly the planting of all forest trees as shelter belts, rather than in the form of isolated squares, as is too common. Plant any of the kinds named in the succeeding list, but plant in the order suggested, as many trees do famously well planted east or south of a heavy belt of hardier trees, which would utterly fail in open exposure to wind-sweeps.

PLANTATIONS FOR FUEL, FARM USES, AND MANUFACTURING PURPOSES.

To economize space, we place the varieties of trees best suited for these varied purposes under one heading, making comments as to relative value for specific purposes and management of each timber tree separately.

GREEN ASH (*Fraxinus viridis*).—For fuel, and for all the manifold uses for which light, firm, elastic, and durable timber is wanted, as well as handsome, light-colored finishing lumber, the white and green ash are our most valuable trees, and their greatest value is attained when grown on deep, rich soil. The white ash (*F. Americana*), in our dry atmosphere, and sometimes very dry soil, makes comparatively slow growth, while green ash, on soils favorable for our best corn crops, will in ten years be as large as the ash-leaved maple (*Negundo aceroides*) of same age. For all uses its timber is very similar to white ash, with which it is confounded by most of our citizens. It grows in many parts of Iowa, while the white ash is not common. The seeds ripen in October, and soon fall after frost. A good way to keep them is to place them on the surface of a garden walk, putting a box over them, and cutting a trench around the box to keep water from running under them. They will not grow if kept too dry. With most people it will be best to purchase the plants of nurserymen, or to cultivate the first year in a seed-bed. Usually about one-fifth of the seed grows. Transplant where they are to grow at one year old. It is, however, better for the trees to plant the seed where the trees are to grow, say six or eight seeds in a hill. They will then retain their tap-root and grow with more vigor, but will require more hoeing.

How to plant.—After deep plowing and thorough harrowing, mark the ground as for corn. If seeds are planted, cover shallow, not more than an inch. If transplanting, press a clean, bright spade about two-thirds its length perpendicularly at each intersection of the marks, then draw the handle back, so as to move the bottom of the spade three or four inches forward, then press in the spade the balance of its length, and push the handle forward, which will leave an ample hole to receive the roots; after the spade is withdrawn, tramp the ground firmly on the roots, and leave the plant standing perpendicular.

HONEY-LOCUST (*Gleditschia triacanthos*).—It is thought by many to be best to select the seed for timber-growing purposes from thornless trees, yet it often happens that nearly all the plants from seeds gathered from very thorny trees will prove thornless if kept thriftily growing. On account of rapidity of growth and value of timber for fuel, posts, furniture, &c., we regard this native tree as being very valuable. In some of the interior counties remote from the river bottoms, where this tree is found native, the idea seems common that this tree, like the common black locust, is subject to attacks of the borer, and is also liable to sprout, &c. For the benefit of this quite numerous class it may be well to state that honey locust—or more properly three-thorned acacia—is nearly allied to the Kentucky coffee tree botanically, and that the borer has not been known to attack it; nor does it sprout to greater extent than the maple and most other forest trees.

The seed ripens in autumn, and may be gathered any time during the fall or winter. But the sooner pods are gathered after falling to the ground the better. In Cedar County, on Cedar River, and at many points on the Iowa, Des Moines, Missouri, and indeed most of the rivers of the State, pods may be gathered in quantity grown on thornless trees.

Before planting, scald the seeds severely. Part of them will swell. Sift these out with a coarse fanning-mill sieve. Scald the remainder again; repeatedly scalding and sifting, until all are swelled. The ground should be ready and the seeds at once planted. They will come up in two or three days, if the weather be favorable, and their upright growth is so rapid that less care is needed in picking out weeds from among the plants than with any other forest-tree seedlings. Keep the weeds down carefully with good culture during the summer. Take up the plants in the fall and heel in carefully where water will not stand. If left standing in seed-bed, the plants are often injured during the winter. After the first year the plants are perfectly hardy, if seed from our native trees be used. We may here note that the seed sold in the Eastern markets is mostly imported. The plants produced from the foreign honey-locust seed prove as tender in our climate as the peach tree. No valuable tree in our list bears transplanting with as little check to growth as the honey-locust. Put out the plants with a spade, as recommended for the ash.

Black Cherry (*Cerasus serotina*).—The great value of this tree for posts, fuel, manufacturing, &c., has been too much overlooked. Plantations in this State, and in Illinois, demonstrate it to be one of our most desirable trees for cultivation, attaining a size in 12 years about equal to scarlet maple, with same care. When planted thickly, say in rows 4 feet apart and 18 inches apart in row, the poles run up tall and straight. The trees taken out in thinning can be utilized for poles to nail on posts for fence. Cut in summer, when they will dry quickly, they will last many years. When used for posts, if thoroughly dried, the writer has found them to last as long as the best burr-oak. He has posts yet sound that have been set 15 years, and made from trees only 10 to 12 inches in diameter. The seed may be gathered in most of our groves and thickets Wash off the pulp, dry the surface of the pits in the sun, then pack in pure sand, in small boxes or nail kegs. If kept in cellar, where they will not get too dry, they will grow; or they may be buried where they may be severely frozen. In the latter case, they will be found to germinate very early in spring, and must be sown before much started. Plant and manage same as ash. If planted where wanted, all the better; as transplanting sadly retards growth.

European Larch [*Larix Europœa*].—In Europe, this is regarded their most valuable forest tree for artifical groves. It is especially grown for railroad ties, posts, vine stakes, fencing, fuel, and about all the economic uses of the farm, and even in the ship-yard; whole ships having been constructed of larch timber. It is in our country one of the most rapid growers we have, under proper treatment. But we may suggest that a careless manager had better select some other tree. The indications are that it will not prove as desirable here as in Europe, perhaps mainly on account of too rapid growth on rich soils. On their clay soils it produces a better grade of timber.

Purchase plants that have been once transplanted. Be sure to secure the plants very early in the spring. The leaves start very early, and the plants should be in the ground before this occurs. If much started they can hardly be saved in the open air, unless the weather be very favorable. Remember that it will not bear exposure of root, any more than the evergreens. In planting keep the roots in mud and water, under no circumstances allowing them to get even partially dry. Plant the same as ash and honey-locust.

For the first year or two after transplanting, they will be found to make very moderate growth. After that they climb up rapidly. The ash and locust will need thorough culture but two years. The larch will not shade the ground as early, and will need four years of careful culture. We will add, if plants of two years' growth be purchased, that have not been transplanted from the seed-bed, do not think of setting in the open field. Plant quite closely in bed, and give partial shade for one or two years. It pays to grow larch, but the idea must be kept constantly in mind that when young it is very delicate and tender under our dry air and hot sun, and must be handled in all respects like young evergreens, with the additional care that it must be transplanted very early in spring.

Black and White Walnut [*Juglans nigra, and J. cinerea*].—These are well known and valuable trees, especially the black walnut. They do not transplant without great check of growth, and the nuts, therefore, should always be planted where wanted for belt or grove.

Judge C. E. Whiting, of this committee, who has had more experience in growing this timber than any man, probably, in the West, reports as follows:

"If I were to plant a section of timber for an investment for my children, I would have it all black walnut—a tree will grow to sawing size sooner than pine, and even now in our markets it is quoted at three times the price of pine. It is very durable, if put in the ground dry, for posts. Fifteen years ago I planted cedar and walnut posts at the same time, and also posts of white oak. All are now decayed about equally. Always plant the walnut where you want it. Will transplant well, but loses, in losing its tap-root, years of growth. Seven bushels of walnuts, with the shucks on, will plant an acre. During the winter I put in trenches, not too thick, and cover with leaves."

Plant before sprouting if possible. Mark the ground out as for ash, and plant the nuts early and deep so that they will not dry.

Yellow Cottonwood [*Populus monilifera*].—The opinion is common in Central and Eastern Iowa, that cottonwood is only valuable on the prairies for wind-breaks, as the wood has little value for fuel or for any uses of the farm or workshop. The variety, if it be merely a variety, abundant on the Missouri, and also found sparingly on the Des Moines, Iowa, Cedar, &c., in Central and Eastern Iowa, known as yellow cottonwood, really has an economic value, aside from its value fer shelter-belts, that should be better understood by our prairie settlers. Bryant says of this variety: "Its heart-wood is of a yellowish color, not unlike that of the tulip tree. It grows in the same situation as others of its kind, and is split without difficulty into rails. Shingles have been manufactured from it, which lasted a considerable time. When sawed into lumber it does not warp like the cottonwood generally. If *Populus angulata*, and *P. monilifera* are really distinct, it is a matter of uncertainty to which this variety

belongs. The subject should be investigated." Judge C. E. Whiting has grown this tree extensively for a number of years on the Missouri bottom in Monona County, and has expressed his views as follows:

"We have in the Missouri bottom both the white and the yellow cottonwood. In speaking of the cottonwood as a valuable timber, I speak alone of the yellow. I have fence-boards of this yellow cottonwood upon my farm that have been in use fifteen years, and they are yet good. My house is sided with cottonwood; has been built ten years, and looks as well as any pine siding in the country, and stays to its place as well. It is really better as fencing than pine, being tougher and stronger. It stays to its place as well, and is equally durable. I need hardly say it has no rival in rapidity of growth, as it far outstrips the willow. Along the bars of the Missouri are millions of seedlings. They grow up upon these bottoms over a great extent like prairie-grass. There are enough of them to plant groves over every prairie in the State. I went ten miles from home, and in one day took up 13,000 eighteen to thirty inches in height for my own setting. With ground ready a good hand can set 2,000 to 3,000 per day. The fall is the best time to get seedlings from the Missouri bottom, on account of the high water in the spring. I set cottonwood posts from old trees on the bottom in the spring of 1860. I moved this fence last fall, and nine-tenths of them are yet good. The yellow cottonwood, split up green and put under a dry shed to dry, is good enough for my folks to use for fuel.

"Of my first planting of cottonwood twelve years ago, the best of them now measure sixteen inches in diameter. We would make plantations very thick. I now plant 4,356 trees to the acre. This shoves them up straight and symmetrical. In this way we get the dead-sure thing on the side-branch business. Cottonwood can be readily grown from seeds. Being upon the river-bottom in June, I noticed the cottonwood trees were loaded with seed; had one cut down and loaded the wagon with branches with the seed attached. I furrowed some ground quite deeply with plow; strewed the limbs in the rows, and my success in growing many thousands of seedlings was most perfect."

In the interior sections, where seedlings cannot readily be obtained from the river bottoms, the yellow cottonwood may be grown from cuttings about as readily as the willow. The evident advantage would also ensue of propagating the right variety. On the Missouri bottom the seedlings of the common cottonwood are, of course, intermixed with the more valuable variety.

CATALPA [*Catalpa bignonoides*].—Experience has demonstrated this tree to have a special value for extended planting. Although naturally a tree indigenous farther south, it seems to have a peculiar tendency to adapt itself to northern limits. A variety now grown quite extensively in Central Iowa seems as hardy as any of our native trees. The writer has trees now five years set, large enough for small posts for wire fences, which have had open exposure north of 42d parallel during the past severe winters. In Cedar County are to be seen many trees, which have been out from ten to fifteen years, which show its habit of rapid growth to continue after it attains considerable size. In its native forests it attains considerable size, growing from 50 to 80 feet in height, with a diameter of from 18 to 25 inches. Its flowers are very showy, and its odd cylindrical pods attract much attention. It is very durable for posts. Posts are yet sound in Illinois which have been set, it is claimed, forty years. The plants are very easy to grow from seeds, which may be kept dry until time for sowing. But in all cases secure seed grown on northern trees. In Cedar County, and near Muscatine, the seeds are quite abundant. The trees flower and bear seeds abundantly when quite young.

WHITE AND SCOTCH PINES [*Pinus strobus* and *P. sylvestris*].—These have been referred to in this report as very desirable for shelter belts. Our people have been slow to plant them for timber trees as their most evident use as such is for sawed lumber. Admitting this as their special use, several considerations should induce their extended planting:

First—their rapidity of growth. Very many reported cases of growth on the prairies of white pine, in partially sheltered localities, confirm the statements of relative growths made by D. C. Scofield, of Elgin, Ill. His plants were set when from 6 to 12 inches in height, and after twelve years' growth he reports European larch 30 feet high and 8 to 12 inches in diameter; and white pine 35 feet in height and 6 to 12 inches through. The writer has white-pine trees, twelve to thirteen years planted, 14 inches in diameter and over 30 feet in height.

Second—the poles thinned out as before stated are valuable for fencing.

Third—An evergreen plantation breaks up the monotony of prairie scenery, and adds in this way a moneyed value to our real estate in case it is offered for sale.

Plants of white pine can be bought from dealers, who collect them in the pineries as low as two to three dollars per thousand, in quantity. Such plants should be set in beds for two years, and screened by light brush-covered shed. They may then be set where wanted. Pine and larch may be grown advantageously intermingled in the same plantation. As before noted, the Scotch pine may be judiciously planted as a

protection to white pine or larch plantations on west or north sides. Evergreen plants can be procured of parties in Illinois who grow them from seed and send them out once transplanted at low rates. Robert Douglas, of Waukegan, Ill., whose long experience in prairie-tree growing gives a practical value to his opinions, advises the extended planting of white and Scotch pines intermixed with the larch. He says:

"Most European planters prefer mixing pines with larches, as this adds to the appearance of the plantation and gives a choice in thinning. We would advise planting a few rows of the admixture on the margin of the plantation, at least, and in all cases where the plantations are placed along the outer boundaries of the farm, we would recommend a free admixture of evergreen."

As evergreen plants are usually shipped from a distance, the instructions of Mr. Douglas in regard to handling and setting are appended:

"When the trees are received from nurseries the boxes should be immediately unpacked, and the roots dipped in a puddle made of rich mellow soil, about the thickness of paint. Place them in a cool shaded place till ready to plant, and while planting expose the roots as little as possible. If not ready to plant for a few days, keep the *roots moist* and *tops dry*. Set the trees a little deeper than they stood in the nursery, and tread the earth firmly about the roots when planting—*this is very essential*—drawing a little loose earth up to the trees to prevent the surface from baking."

RED ELM[1] [*Ulmus fulva*].—This tree has not received the attention it merits from tree-planters on our prairies. It is peculiarly a tree adapted to dry climates, no better proof of which could be found than the fact that it fails to ripen seeds in the humid air of England and France. Its special claims to attention for extended planting may by briefly summed up as follows:

(1) It is beyond all question hardy, even in the most exposed position on our prairies.

(2) It grows on rich soils with great rapidity. The writer has trees grown from seed in six years larger than box-elder [*Negundo aceroides*] of the same age, and receiving the same treatment.

(3) The seeds are easy to gather in nearly every portion of the State, and require no more skill in handling and planting than of the soft maple.

(4) No tree in our whole list seems so free from disease, and injury from insects, worms, &c.

(5) No tree, not even the larch, has so large a proportion of red or heart-wood when young. Even in the branches of young trees only one or two inches in diameter the perfect wood forms the principal part.

(6) Grown thickly in artificial groves it runs up straight and tall, and when the poles are large enough to split for two rails they divide as freely and easily as young chestnuts, and the rails are about as durable, even when laid up in worm-fence. Nailed on to posts they will last fully as long as white oak.

(7) When the poles are only large enough for a grape-vine stake, or a small post for wi e fence, if cut in summer, peeled, and dried before setting, they will last longer than burr-oak, set green, from old trees.

(8) It is a historical tree of our country, and associated with every memory of the early days, without much regard to position, as it seems the one ubiquitous tree, nearly everywhere present in the native forests of our country. It is among the first in the spring to exhibit its blossoms and hue of cheery green, and in the autumn, with the advent of the early frosts, it presents a display of shaded leaves, running from lightest violet and the deepest crimson, to all shades of orange and yellow. Other things being equal, even beauty has a moneyed as well as æsthetic value in the arrangement of the landscape view in tree planting.

This special commendation of the red elm may be received with some doubt by those who have given the matter little attention. The idea is not intended to be conveyed that exclusive plantations be made of any one tree. But example and habit have too much influence in guiding tree planting. The soft maple, for instance, has become over our State the popular tree for general planting. Let us suppose the red elm has become equally popular. It grows as rapidly, it is far hardier, it is freer from insect ravages, it is worth far more for fuel, it is exellent for rails and even posts, its lumber is valuable for stable-floors, bridge-plank, wagon-hubs, and many other uses, the trees require little if any care in the way of pruning, &c. If it could supplant the maple the gain would soon be very apparent.

The seeds of the elms ripen in May, usually before the trees come into full leaf. The seeds are light, and being surrounded by a membranous wing, they are widely scattered by the wind. Sow at once on gathering, and by all means sow where wanted, if possible. They may be planted in corn-hills to excellent advantage. They usually grow about one foot in height the first season. Planting with corn is an advantage, as the plants are sometimes injured when very young by direct exposure to our dry air and hot sun of July and August. The plants transplant readily, but if you want rapid growth never break the first tap root.

[1] Sometimes known as the *slippery elm*.

CORKY ELM (*Ulmus racemosa*).—This tree in habit of growth is much like the white elm [*Ulmus Americana*] but its wood is far more valuable. This elm is so often confounded with the white elm, and is so usually mixed with it in its native haunts, that the masses might fail to get the unmixed seed. The corky elm will be likely to grow as rapidly as the red elm, but its wood having less value for manifold uses than the latter, its extended culture cannot as yet be advised. For ornament and for shelter, however, we may say the white elm in all its northern varieties is not surpassed. Michaux was right when he said that the white elm was "the most magnificent vegetable of the temperate zone." Isolated trees for shade or landscape effect, of any of the white elm varieties, are not excelled. The American elms, as grown from seed, all run into variations puzzling to the botanist.

SILVER-LEAF MAPLE (*Acer dasycarpum*).—This variety, and also the red maple [*Acer rubrum*], are well known plantation trees in every neighborhood of the West. It is economy of time, and a great increase of growth is attained by planting where wanted as recommended for the ash. But seedlings may be transplanted readily if plants are readily obtainable.

While it is unfortunate for the timber-growing interests of the State that the soft maples of late have been so exclusively planted, we are not willing to advise the total negletc of these trees. Failure often ensues by neglect to gather seeds at just the proper time. When the wild crab-apples are in full blossom the seed is usually just right. Before planting it is best to soak the seeds in water until just ready to sprout. Then plant in moist earth.

BLACK MAPLE (*Acer nigrum*).—This is usually called sugar maple, but its growth is very much more rapid under culture than the *Acer saccharinum*. For fuel and for sugar-making it is specially worthy of culture. For five or six years after planting its growth is rather slow. After this it compares favorably with our other valuable trees in this list. Seeds ripen in the fall. Pack in sand not too moist, or turn down on walk, and treat as ash seeds, which is generally best. Plant where wanted if possible, as growth is much impeded by transplanting.

ASH-LEAVED MAPLE (*Negundo aceroides*).[1]—This tree is one of the easiest of all to propagate, and for great amount of fuel in a short time it has no superior. In Illinois it is being planted for sugar-making. Its wood in the older States, and in Europe, is used in cabinet-work. Gather seeds in fall; keep under box as with ash, and sow where wanted. Under any kind of culture where a cottonwood will grow, this tree will flourish equally well or better.

HACKBERRY (*Celtis occidentalis*).—Our native variety of hackberry grows very rapidly under culture, and has a special value for making flat hoops for apple and flour barrels. It splits very freely, and if cut in summer, and the bark peeled, the rails when nailed on posts last many years. For fuel it is about like soft maple. The fruit is about the size of peas, and is usually abundant on our river-bottoms. Wash the sweet pulp from the seeds and mix with sand for early spring sowing.

CHESTNUT (*Castanea vesca*).—In the south half of the State, and on first-class fruit soils in the central district, this may be made a profitable tree for cultivation. Of all the trees known to the writer this is the most retarded in growth by transplanting. Trees grown from the nuts where wanted will attain size for small posts while the transplanted ones are hardly large enough for lima-bean poles. Good success has been attained by planting the nuts in Yankee corn-hills, giving the corn good care and keeping the hills free from weeds. After gathering the corn, before cold weather, break the stalks so as to make a partial shelter over the plants. The second year cultivate well until first of July, after which let weeds grow to shade the ground. The chestnut is specially injured when young, (and the same holds good with all forest-trees to greater or less extent), by excessive heating of soil under our August sun. After the third year the ground will be well shaded with the trees and they will make rapid growth, and will richly repay for the trouble and care of management while young. The chestnuts to be used for seed must not be allowed to become dry, or to mold or heat from being too closely confined. They should be mixed with pure sand and kept through winter where they will be damp but not too wet. Seed grown north is every time preferable. Nuts grown in Benton County have produced seedlings standing our climate better than those coming from the east or south.

RED MULBERRY (*Morus rubra*).—This is a very handsome ornamental tree, growing very rapidly during the first years after planting, and soon attaining size suitable for grape-vine or other stakes, and even for posts. The timber is strong, compact, and very durable. If dried before set in the soil, it is questionable whether we have any timber, doing well in rich soils, as durable for posts or stakes as this. A drawback to its culture is the scarcity of seed, the birds generally getting the fruit as fast as ripe. Wash the pulp from seed and mix with sand for early spring sowing, either in seed-bed or where wanted. Plant the mulberry where sheltered from the west and northwest by belts of trees like elm or cottonwood that will better stand the rake of

[1] By some botanists called *Acer negundo*.

our dry, cold winds. It also does best on porous, deep soils, as long continuous drought seriously injures and even kills the trees on soils with the blue clay too near the surface.

YELLOW BIRCH (*Betula excelsa*).—This tree thrives exceedingly well on deep, rich and moderately moist soils, with porous subsoil. It makes excellent fuel, and is valuable for many manufacturing purposes where a strong, fine-grained, handsome wood is desirable. It is only recommended for variety. It grows readily when transplanted; and the lover of trees will always be pleased to have it in a general collection. The seedlings are not so easy to grow in our dry air as those of most forest-trees, and the seed, of which there is an abundance in the market, is usually not in a condition to grow. The plants may be bought in any quantity in the pinery regions at low rates.

LARGE ASPEN (*Populus grandidentata*).—Unlike the common aspen this tree rapidly attains, under cultivation, considerable size. The wood has no great value for fuel, yet it has a special value for farm-uses that should not be overlooked.

(1) It grows when planted closely very straight, and the poles—cut in summer and pealed—flattened on one side make very strong and stiff rafters for sheds and even barns. When large enough for hewing-sticks it is fully equal to white pine for frames of barns.

(2) No timber in our list will attain, under good culture, size sufficient for two rails as soon, that is equally strong and durable, if cut in summer and peeled. In lengths of eight or nine feet nailed on good posts, they keep in place better than oak, and will last fully fifteen years.

All things considered, it is best to grow this tree from cuttings, yet where seed can be procured the plants grow with as much certainty as the cottonwood or maple.

We may add that a plat of the aspen on the open prairies is ever an object of interest in contrast with other trees. The leaves tremble in the lightest breeze when the foliage of other trees is motionless.

WHITE POPLAR (*Populus alba*).—This tree is usually voted a nuisance as a shade on account of its wonderful tendency for suckering; but this tendency to sucker would be no objection in forest-culture. The size which this tree will reach in prairie soil in ten years is a matter of wonder and surprise. It is probable that we have no tree with valuable wood that will reach saw-log size as soon as this. Like the elm, the intrinsic value of this tree has been overlooked. Let us enumerate:

(1) It propagates from cuttings of any size, even more readily than the willow.

(2) It is valuable for about the same uses as the famous tulip tree (*Liriodendron tulipifera*) of Ohio. It makes very superior flooring, wainscoting, and even finishing lumber for houses. The boards used for siding, or for fencing, are vastly superior to any of the poplar family except it be the yellow cottonwood. For dry-goods boxes, bowls, trays, carriage-bottoms, trunk-making, chair-seats, &c., the wood is counted in Europe superior to pine or white-wood.

(3) When thickly planted, it runs up very straight, and the poles cut in thinning, can be utilized by nailing on posts for fence, for rafters, sleepers, etc., as with the aspen. As with the latter, the trees for this use should be cut in summer and peeled, when they are quite durable if kept from the ground.

WILD RED CHERRY (*Cerasus Pennsylvanica*).—This is a small-growing tree in its native haunts; but it behaves so well under cultivation, that it deserves a place in our timber plantations. It is peculiarly a northern tree, being found on nearly all soils from the Atlantic coast to the headwaters of the Mackenzie River in British America. It is very nearly allied to the common cultivated cherry, and exhibits in its seedlings a marked capacity for variation and improvement. A variety is in common cultivation in the south part of Benton County, Iowa, which bears heavy annual crops of fruit, which is considered excellent for culinary use. The fruit is fully as large as that of the black wild-cherry, and of pleasant flavor. The wood of this tree is exceedingly hard, fine-grained, and of a reddish hue, and would be valuable for many uses in cabinet-work, were it not for the natural small size of the tree. Grown thickly in artificial groves, its poles are straight and tall, and valuable for such farm-uses as nailing on posts, fence-stakes, vine-stakes, light fence-posts, &c. If dried before putting in the ground it lasts as well for posts as black cherry. The pits kept in sand through winter grow as readily as those of black cherry. It transplants readily, and sprouts can be secured in nearly all parts of the State for setting in groves. It will not pay to grow this timber except for home-use on the farm.

WHITE WILLOW. (*Salix alba*).—Perhaps it may not be proper to include the willow among the timber-trees proper, having a special value for farm-uses or for manufacturing. Yet where grown thickly the poles are straight and uniform in size, and if cut in summer and bark peeled off, they last for several years nailed on posts for fence, and the fuel if dried under cover has a greater value for summer use than is generally supposed. It is specially mentioned in this connection on account of its combined adaptation for wind-breaks and fences on the bleak interior prairies. If any one doubts the expediency of growing the white willow on an extended scale let him pay a visit to Story County, Iowa. Several years since Col. John Scott, of that county,

earnestly advocated the extended planting of this tree for fences, for fuel, and for the arresting of wind-sweeps on their bleak, broad prairies. In the portion of the county where its planting has been general, one can now hardly realize he is upon the open prairie in driving along the streets, lined on both sides for miles in extent, with combined fence and wind-screen. Where best known, the wonder is expressed by prairie-settlers how they got along before its advent in their neighborhood. Thomas Wardall, of Mitchell County, who has had a long prairie experience, writes of the white willow as follows, in a report on hedges for the North:

Seventh. We tried the white willow. This has come to us at the north as a "God-send." Not because it makes the best hedges, for no one is so foolish as to assume that, but because a stock-proof fence *can* be made of it, in brief time, and at small expense, which at once is a fence and a wind-break. A combination of this kind the denizens of our northern prairies can appreciate. The variety mostly in use in our section and in Minnesota will not bear plashing or even weaving, and will not lose the tree habit of growth by being headed back. So we have by mutual consent abandoned all attempts at hedge-making proper, and we aim to secure a close bottom at once, then give protection from stock for two years, and we have a profitable investment in what will become a solid wall of live timber in a very few years; at once a fence, a valuable screen from the sweeping winds of summer and winter, and which will give a constant supply of passable fire-wood from the tops. And now for the plan for forming such a stock-barrier, to which I will ask special attention. Let every northern farmer plant out a willow grove, with good large cuttings in early spring. Plant four feet apart, both ways, and cultivate well for two or three years, and a large growth will be secured. When five years old, trim out all but one plant to each hill. Cut off stakes five and one-half feet long from these trimmings. Sharpen these stakes and drive them eighteen inches deep in a well-prepared fence-row. When the soil is soft in the spring the driving can be done without bruising the bark. Let the stakes be driven closely, not more than six inches apart. Nail a stay-lath near the top. A three-inch barn-batten answers the purpose well. Mulch heavily or cultivate well and often. In two years a fence may be made that may be depended on to turn stock, but which will have the one fault of not being beautiful.

Premiums of the Iowa Horticultural Society for 1877.

The following premiums are offered to encourage the planting of trees in permanent timber plantations or belts; the number of trees living to be ascertained by actual count between the 15th of September and the 10th of October, 1877. The award of the premiums to depend upon a full compliance with the rules appended to the schedule of premiums.

For the greatest number of species planted in groves; intrinsic value of species considered	$40 00
Second greatest number	25 00
Third greatest number	10 00
For the greatest number of evergreens and larch in plantations or belts	20 00
Second greatest number	15 00
Third greatest number	10 00
For the greatest number of ash trees	20 00
Second greatest number	15 00
Third greatest number	10 00
The greatest number of nut-bearing trees, including oaks	20 00
Second greatest number	15 00
Third greatest number	10 00
For the greatest number of black wild cherry, elm, box-elder, and birch	20 00
Second greatest number	15 00
Third greatest number	10 00
For the greatest number of cottonwood, basswood, willow, maple, and other soft-wooded trees	20 00
Second greatest number	15 00
Third greatest number	10 00
For the greatest number of honey-locust—(from seed grown on thornless trees is preferable)	20 00
Second greatest number	15 00
Third greatest number	10 00
	$345 00

REGULATIONS.

1st. Persons competing for premiums must designate the class for which they compete, as, for greatest number of soft-wooded trees, greatest number evergreens, larch, &c. A plantation may consist of a single variety enumerated, or any number of the kinds mentioned.

2d. Additional plantations must be made for each separate entry for premiums. In

other words, a person awarded a premium in one class will not be entitled to a premium on same trees in another class.

3d. The plantations competing for these premiums must be made with rooted seedlings or plants, with the exceptions here mentioned: Of willows and soft-wooded trees growing readily from cuttings, strong cuttings may be used. In the class of nut-bearing trees, white walnut, black walnut, and oak may be started from seed where wanted to remain.

4th. All trees, seeds, and cuttings must be planted in permanent timber plantations or belts, in the spring of 1877, except where parties failed in getting a sufficient stand in 1876, they may replant in 1877. The plantations must not be made at a greater distance than four feet each way; when counted there must be at least two thousand trees to each acre. The plantations competing for a premium must be on one farm, but need not be contiguous.

5th. The competitor must have his trees counted by two disinterested winesses between the 15th of September and 10th of October, counting only those that are alive at that time. After counting, competitor must make affidavit before a justice of the peace or notary public as to the following facts:

(A) Whole number of trees in permanent grove, planted in spring of 1877, and now alive, or if it is a replanted grove, planted in 1876, state the fact. (B) Name and number of each kind planted. (C) How planted. (D) How cultivated. (E) Cost of plantation. (F) Average size of each species of trees.

The parties who counted the trees must append their affidavit as to the correctness of the count. The officer who administers the affidavit shall certify to the identity and credibility of the competitor and the parties who counted the trees.

6th. The above-described affidavit to be forwarded to the secretary of the State Horticultural Society, Joseph L. Budd, Ames, Story County, Iowa, not later than December 1, 1877.

7th. Premiums will be awarded at the next annual meeting of the society, at the city of Des Moines, on the third Tuesday in January, 1878.

H. W. LATHROP, *President.*

J. L. BUDD, *Secretary.*

The Annual for 1875 gave a list of 74 species distributed among 29 genera, as recommended for planting. The list include, besides those above mentioned, the balsam and Douglas firs (*Abies balsamifera* and *A. Douglasii*); horse-chestnut (*Æsculus hippocastanum*); ailantus (*A. glandulosa*); sweet, red, and canoe birch (*Betula lenta*, *B. nigra*, and *B. papyracea*); hickory (*Carya*, 5 species, viz: *alba*, *glabra*, *amara*, *olivæformis*, and *sulcata*); chinquapin (*Castinea pumila*); cypress (*Cupressus thyoides*); thorntree (*Cratægus coccinea* and *C. crus-galli*); red, black, and blue ash (*Fraxinus pubescens*, *F. sambucifolia*, and *F. quadrangulata*); Kentucky coffee-tree (*Gymnocladus Canadensis*); tamarack (*Larix Americana*); osage (*Maclura aurantiaca*); Austrian and Western yellow pine (*Pinus Austriaca* and *P. ponderosa*); narrow-leaf cottonwood (*Populus angustifolia*); sycamore (*Platanus occidentalis*); oaks, 8 species (*Quercus macrocarpa*, *Q. obtusiloba*, *Q. alba*, *Q. castanea*, *Q. tinctoria*, *Q. coccinea*, *Q. rubra*, and *Q. palustris*); sumac (*Rhus glabra*); willow, 3 species (*Salix viminalis*, *S. nigra*, and *S. Forbiana*); basswood (*Tilia Americana*); and winged elm (*Ulmus alata*).

The Iowa Horticultural Society fixed upon the 20th day of April, 1874, and afterward annually, unless changed, as a day to be devoted to the planting of trees and seeds of trees, designed to form permanent groves or for ornament. This day proving cold and stormy the first year, planters competing for premiums were allowed the next year to select the time most convenient.

In earlier numbers of the Forestry Annual, the following suggestions are also offered:

Prairie farms need shelter most on the west, next on the north, next on the south, while their usefulness on the east is not so great, though sufficient to call for planting. * * * A good combination for an evergreen belt is two or three rows of white pine for center, two rows of Scotch or Austrian pine on each side, and two rows of red cedar or arbor vitæ outside of these, making ten or eleven rows, and giving, by different rates of growth, a belt with a conical cross-section, and limbs from the ground up. Another good combination is made of Norway spruce for center, white spruce next, and black spruce and red cedar or arbor vitæ outside.

The Scotch pine is in many localities found well adapted for outside rows, from its hardy habit. It needs more room for growth than the white pine. In planting wind-breaks, it was recommended that the outside rows should be 9 feet apart, and plants 5 feet apart in the rows. It was remarked that people generally are apt to overestimate the time it will take to secure returns of fuel from artificial groves. Cottonwood needs to be thinned the fourth or fifth year. If properly grown and cultivated, the poles then cut out will average 2½ inches in diameter at bottom, and 12 feet long. From a full stand, one-half, or 1,775 poles, would be cut at this period from an acre. Green ash needs thinning at six or seven years, and makes poles as large as those of the cottonwood at four or five. Those who had tried it say that it pays better to raise wood for fuel than to haul the supply needed five miles for ten years.

As for wood grown for other uses than as fuel, it was estimated that a crop of ash for hoop-poles, or larch for stakes, might be grown in from seven to eleven years, and of oak and hickory in twelve to sixteen years. Larch would grow to a size for posts in twelve to fifteen years, and for telegraph-poles in eighteen to twenty years, on valley lands. Walnut, hickory, elm, and other tie timber might be fit for use in from fourteen to eighteen years. Cottonwood might be sawn at fifteen years and white pine in thirty.

Planted Timber-lands in Iowa, as reported by the State Census in 1863, 1865, 1867, 1869, *and* 1875, *and Natural Timber in* 1875.

Counties.	Acres of planted timber.				Timber and forest products, 1875.			
	1863.	1865.	1867.	1869.	Acres of natural timber.	Acres of planted timber.	Total acres of timber.	Value of forest products.
Adair	26	30½	19	39	6, 961	570	7, 531	$9, 241
Adams	54	47	52	57	8, 687	411	9, 098	16, 611
Allamakee	1	....	1½	2	61, 956	326	62, 282	29, 240
Appanoose	3¼	0½	....	3	62, 037	141	62, 178	53, 745
Audubon	0¼	....	8½	7	2, 843	116	2, 959	2, 476
Benton	295	492	613	943	18, 016	3, 603	21, 619	39, 738
Black Hawk	96	174	266	708	15, 834	1, 812	17, 646	39, 400
Boone	3	9	42	66	27, 550	380	27, 930	45, 314
Bremer	32	114½	194	183	21, 090	379	21, 469	62, 813
Buchanan	72	47¾	185	374	20, 759	448	21, 207	27, 397
Buena Vista	....	....	....	....	847	642	1, 489	1, 460
Butler	51	71½	137	458	12, 844	3, 496	16, 340	45, 519
Calhoun	....	....	1	22	1, 290	520	1, 810	....
Carroll	214	7½	8	97	3, 912	685	4, 597	12, 483
Cass	12	21	40	65	5, 860	731	6, 591	18, 679
Cedar	282	656[1]	300	493	36, 100	1, 010	37, 110	67, 778
Cerro Gordo	2	6	35	85	4, 886	386	5, 272	19, 350
Cherokee	....	....	....	9	1, 085	570	1, 655	2, 315
Chickasaw	9	11	30	95	17, 374	483	17, 857	22, 196
Clarke	25	31¾	49	67	21, 573	191	21, 764	195, 414
Clay	....	....	....	14	729	843	1, 572	8, 351
Clayton	10	1	73	34	99, 222	94	99, 316	93, 077
Clinton	208	151	85	910	22, 912	422	23, 334	14, 513
Crawford	1½	12¼	17	241	5, 376	433	5, 809	8, 859
Dallas	885	85	203	168	24, 651	742	25, 393	24, 763
Davis	27	359	3	15	81, 772	182	81, 954	52, 469
Decatur	156	44	53	111	43, 041	200	43, 241	41, 737
Delaware	83	91	148	179	45, 181	652	45, 833	65, 548
Des Moines	12	25	8	29	46, 976	60	47, 036	112, 624
Dickinson	....	....	....	....	1, 194	379	1, 573	5, 098
Dubuque	5	17	3	60	69, 773	107	69, 880	127, 500
Emmett	....	3	9	20	1, 234	193	1, 427	2, 693
Fayette	163	246	181	388	38, 539	977	39, 516	73, 890
Floyd	28	142	34	102	17, 294	528	17, 822	66, 610
Franklin	26	275	59	143	4, 185	815	5, 000	7, 795
Fremont	15	29	151	125	23, 924	341	24, 265	33, 901
Greene	6	11	17	31	9, 410	230	9, 640	27, 703
Grundy	107	121	170	349	866	1, 420	2, 286	....

Planted Timber-lands in Iowa, as reported by the State Census in 1863, *&c.*—Continued.

Counties.	Acres of planted timber.				Timber and forest products, 1875.			
	1863.	1865.	1867.	1869.	Acres of natural timber.	Acres of planted timber.	Total acres of timber.	Value of forest products.
Guthrie	42	61	117	104	14, 180	747	14, 927	$15, 197
Hamilton	4¾	24	67	109	8, 172	876	9, 048	10, 011
Hancock	1⅝	....	13	23	10, 000	114	10, 114	6, 991
Hardin	162	175	266	464	18, 106	961	19, 067	40, 841
Harrison	28	29	30	107	23, 497	528	24, 025	39, 402
Henry	56	250	84	130	44, 178	312	44, 490	59, 003
Howard	9¾	36	220	195	10, 493	534	11, 027	10, 421
Humboldt	39	16	53	125	1, 878	309	2, 187	11, 298
Ida	....	....	5	10	703	56	759	2, 216
Iowa	68	114	90	166	22, 973	506	23, 479	24, 897
Jackson	7	7	9	3	95, 160	27	95, 187	78, 472
Jasper	103	132	179	237	29, 223	1, 212	30, 435	32, 390
Jefferson	100	27	77	2, 846	55, 478	99	55, 577	45, 397
Johnson	400	151	356	200	39, 971	622	40, 593	75, 765
Jones	280	182	579	316	52, 546	473	53, 019	54, 376
Keokuk	736	94	644	121	45, 000	400	45, 400	50, 635
Kossuth	2	4	19	94	2, 344	583	2, 927	2, 310
Lee	13	(2)	130	178	68, 716	80	68, 796	68, 068
Linn	65	106	211	326	63, 383	815	64, 198	116, 166
Louisa	120	92	29	47	37, 299	178	37, 477	66, 706
Lucas	59	253	306	127	22, 884	150	23, 034	31, 717
Lyon	....	....	....	....	691	145	836	260
Madison	43	46	121	134	34, 426	910	35, 336	36, 737
Mahaska	84	630[1]	212	348	46, 132	544	46, 676	56, 566
Marion	12	413	466	74	49, 181	221	49, 402	41, 315
Marshall	207	270	4, 574[1]	1, 080	15, 687	5, 526	21, 213	34, 153
Mills	330	596[1]	144	235	18, 502	749	19, 251	44, 101
Mitchell	3	6¾	11	90	12, 188	810	12, 998	30, 822
Monona	15	....	98	161	8, 728	536	9, 264	17, 722
Monroe	14	(3)	7	42	36, 397	38	36, 435	25, 535
Montgomery	41	10	4	39	7, 445	320	7, 765	12, 403
Muscatine	255	685	18	733	32, 077	4, 373	36, 450	31, 413
O'Brien	....	....	....	....	207	484	691	39
Osceola	62	....	....	....	....	122	122	....
Page	....	102	72	153	16, 756	1, 502	17, 258	27, 613
Palo Alto	....	1¼	....	27	1, 324	364	1, 688	1, 643
Plymouth	....	2	....	9	578	917	1, 495	2, 055
Pocahontas	....	....	6	19	651	420	1, 071	....
Polk	76	50	103	120	38, 623	705	39, 328	51, 134
Pottawattamie	13	8	154	1, 200[1]	20, 483	600	21, 083	107, 852
Poweshiek	132	145	170	223	12, 197	777	12, 974	13, 668
Ringgold	30	38	39	56	18, 149	226	18, 375	43, 123
Sac	1	1½	1	10	2, 662	624	3, 286	6, 352
Scott	478	(2)	178	256	15, 464	228	15, 692	17, 382
Shelby	2¾	4	2	29	5, 632	343	5, 975	13, 122
Sioux	....	....	....	....	218	276	494	....
Story	34	46	77	229	14, 165	774	17, 939	41, 126
Tama	97	149	185	384	18, 282	1, 589	19, 871	37, 285
Taylor	51	64	57	224	19, 039	500	19, 539	25, 000
Union	9	15	10	245	9, 203	623	9, 826	11, 451
Van Buren	350[1]	4	6	14	78, 324	384	78, 708	53, 882
Wapello	166[1]	33	29	20	57, 983	76	58, 059	54, 894
Warren	81	122	398[1]	228	34, 718	550	35, 268	70, 113
Washington	252	211	185	397	38, 350	1, 759	40, 109	62, 292
Wayne	40	36	59	53	24, 214	171	24, 385	13, 528
Webster	1¼	16	14	66	11, 330	652	11, 982	10, 326
Winnebago	....	....	0¼	3	2, 779	92	2, 871	....
Winneshiek	377[1]	377[1]	14	57	39, 844	284	40, 128	127, 665
Woodbury	....	....	1	....	7, 204	503	7, 707	13, 782
Worth	....	1	6	22	5, 428	161	5, 589	4, 632
Wright	3	1	28	75	3, 232	574	3, 806	5, 555
Total	8, 360	9, 586¾	14, 128	19, 683	2, 312, 659	65, 549	2, 378, 208	3, 467, 020

[1] Apparently too high, but included in totals.

[2] Returned as 5,662 acres for Lee County in 1865, but, from comparison with former and later years, evidently through error. This remark also applies to Scott County. The totals for the whole State were manifestly in error from these entries, and in preparing this table we have allowed for the two counties a mean between the returns of 1863 and 1867, thus changing, we believe with reason, from printed totals of the census.

[3] Returned as 292, but evidently through error. Allowed as 14 in the total.

Area of inclosed lands and length of Hedges in Iowa at different periods, as shown by the State Census.

Years.	Inclosed lands.		Length of hedges.	
	Acres.	Increase.	Rods.	Increase.
1863	4,784,886	....	306,728	....
1865	5,327,053	542,167	331,741	25,013
1867	8,263,174	2,936,121	663,063	331,322
1869	8,174,930	—88,244[1]	3,393,061	2,729,998
1873[2]	9,987,788	1,812,858	....	....
1875[2]	12,658,493	2,670,705	7,396,662	4,003,601

[1] Decrease, some counties not reporting.
[2] The first of these entries is for "acres improved," understood to correspond with "acres inclosed" of former returns.

There were also reported, in 1875, 9,645,961 acres in cultivation in 1874 and 52,164,603 rods (161,764 miles) of fence. It does not clearly appear whether *hedge* fences are included in this amount or not. If they are, it gives an average of 4.12 rods of fence to each acre of improved land.

The lumber business at Clinton, Iowa, began in 1860, and now employs about 1,000 men, including teamsters and raftsmen. The logs are rafted down from Wisconsin rivers, and the products mostly go westward into the prairie regions.

Lumber manufacture in Iowa.

Most of the lumber manufactured within this State, is grown beyond its borders, and almost entirely in Wisconsin. The business is distributed along the Mississippi, at fifteen different places, which in order of capacity for manufacture are, Clinton, Davenport, Lyons, Muscatine, Dubuque, Fort Madison, McGregor, Burlington, Lansing, Keokuk, Montrose, Camanche, Bellevue, Sabula, and Guttenburg.

The capacity and business of these points were reported by the *Northwestern Lumberman* of March 30, 1878, as follows:

Manufacturing points on the Mississippi River.	Establishments.	Saws.				Feet of lumber sawed in 1877.	Capacity of mills (day sawing).
		Gang.	Circular.	Mulay.	Gang-edger.		
Lansing	2	....	3	....	2	12,500,000	3,075,000
McGregor	1	1	1	....	1	15,180,000	12,000,000
Guttenburg	1	....	1	....	....	2,000,000	1,250,000
Dubuque	5	1	8	1	5	30,500,000	21,250,000
Bellevue	1	....	2	....	1	5,000,000	2,250,000
Sabula	1	....	1	....	1	3,500,000	1,300,000
Lyons	3	3	5	....	5	41,000,000	19,600,000
Clinton	4	13	8	2	13	113,000,000	57,793,567
Camanche	1	....	1	1	1	6,000,000	1,700,000
Davenport	5	4	7	1	5	54,000,000	51,850,185
Muscatine	3	2	5	....	4	41,000,000	25,400,000
Burlington	2	....	3	....	3	15,000,000	1,250,000
Fort Madison	2	....	4	....	2	20,000,000	17,000,000
Montrose	1	....	2	....	1	8,000,000	3,398,800
Keokuk	1	....	2	....	1	10,000,000	4,750,000
Total Iowa	33	24	53	5	45	376,680,000	223,870,552
Total river shore, Wisconsin and Illinois	13	6	19	3	11	107,000,000	52,226,708

The lumber manufacture of Sioux City, on the Missouri River, and on the west line of Iowa, is estimated at about 8,000,000 feet per annum.

About 2,000,000 of the native cottonwoods of the Missouri flats, mostly from the Nebraska side, have been sawed annually for the last twenty years. Within this period tracts once cut off have again grown up into timber of considerable size, and a growth of thirty or forty years would be of sufficient size for sawing. This lumber is used for weather-boarding of barns, &c., and, before railroads were opened, it was the lumber principally used for inside finishing, and for joists, studs, and other small pieces in framing. The present price of cottonwood lumber is about $14 per 1,000 feet. The timber supplying these mills is brought from the country within forty miles around, chiefly on the west side, and the valley of the Big Sioux River, on the line of Dakota.

The trees found best suited for planting on the western border of Iowa, at Sioux City, and vicinity, are the soft maples, box-elder, green ash, and black walnut. The cottonwood is a native, and grows luxuriantly wherever planted. All evergreens heretofore tried, excepting the red cedar, have failed in that region.

LYON COUNTY.—This is in the extreme northwestern corner of the State of Iowa, and in the prairie region.

An experiment in planting was begun in 1871 on an extensive scale. Of more than a million trees and cuttings, then set, about half were living in 1875, notwithstanding dry seasons and grasshopper ravages, and ranged from 2 to 20 feet in height.

The kind planted were the white willow, cottonwood, box-elder, white or silver maple, white ash, honey-locust, European larch, and several species of evergreen. Among the deciduous trees, including the larch, preference was given in the order above named, with a very decided preference to the white willow, not only on account of the ease and certainty with which it grew from cuttings, but from the value of its timber. When thoroughly seasoned before using, it makes durable fences, and it grows well in both wet and dry ground. The grasshoppers, however, are especially fond of its leaves, and may seriously injure its growth in some seasons.

MISSOURI.

This State was originally well timbered in many parts, while extensive regions elsewhere were open plateaus and prairies.

Very little evergreen timber occurs in the State, excepting some cedar in the southeast part. The conifers are equally rare in Iowa, except along Cedar River and adjacent region.

Mr. George Husmann, of Sedalia, in an article published in the State Agricultural Reports (1877), has suggested a method of management for woodlands which, if carefully followed, would insure continued production. A given tract of woodland, say 25 to 50 acres, being inclosed, a portion, say of 5 or 10 acres, should be carefully worked, all old and decaying trees being cut out, and the younger growth thinned. The next year, another part might be taken in like manner, and so on till the whole was worked. Then by going the round again, once in five or ten years, the forest would be gradually brought into a periodical working, more profitable than the hap-hazard way generally practiced.

In planting new land with forest, he gives preference to kinds in the following order: (1) locust; (2) ailanthus; (3) osage orange; (4) European larch; (5) catalpa; (6) white and black walnuts; (7) ash, of all kinds; (8) silver maple; (9) box elder; (10) chestnut. He would break and cultivate one year before; set plants from seed-beds on land marked as

for corn; shorten the tap-root and large side roots; set in furrows, drawing the earth well up against the roots; keep free of weeds, and thin out as needed. He would set in quincunx order, 4 feet apart, or 2,722 trees to the acre, and in 8 years take out half for posts, which should be worth $340.25. In another 8 years, the rest should be worth $680.50; making over $1,000 in 16 years.

In an article published in 1874, he gives preference to the *Catalpa syringæfolia*, and commends the ailanthus, osage orange, ash and maples, although the latter were sometimes injured by borers. Of evergreens he recommended the red cedar, and Scotch, Austrian, and white pines. The Norway spruce, hemlock, and balsam fir did not do well. For shelter-belts, nothing was better than the red cedar.

SAINT LOUIS COUNTY.—The trees chiefly planted for ornamental purposes are the hickory, white oak, and black jack. A few red maples are planted. No pines occur in the county, although the *Pinus mitis* is abundant a hundred miles further south. Seeds of various species of oaks, maples, ash, elm, linden, &c., have been placed by the Missouri Botanic Gardens at the disposal of the Merchants' Exchange, for distribution among the country members. They have always been eagerly sought for, and the demand is invariably greater than the supply. The arboretum of the gardens contains nearly every tree that will grow here in the open air. The following experience in this locality is worthy of notice:

I have lately noticed many 25-year old Scotch pines dying from ravages of the *Pissodes strobi* (Peck.), none of our native pines being affected by it. The black walnut suffers much from the (in other places rare) *Datana angusii.* The flat-headed borer has proved very destructive to the ash trees. It is the same species that attacks the apple-tree, *Chrysobothris femoratus* (Fabricus.). The alders suffer very much of late year from the plant-louse, *Lachnus alnifolia* (Fitch).

On the 1st of January, 1864, the temperature at Saint Louis, Mo., went down to —22° and continued near that temperature for a week. The following trees suffered: *Broussonesia papyrifera*, (killed to the root) *Salix Babylonica* (young trees killed to the root), *Bignonia grandiflora* (young trees killed to the root), *Vitex Agnus castus*, *Pinus tuberculatus* (8 feet; killed), *P. Lambertiana* (5 feet; killed), *P. Coulteri*, *P. Larico* (8 feet; killed), *Cedrus deodora*, *Thuja occidentalis* (young plants), *Sequoia gigantea* (8 feet; killed); grape-vines, peaches, quinces, and cherries were much injured. The Clinton and Concord grapes stood the cold unprotected without injury. The following conifers were much injured, and partially killed: *Pinus maritima* and *excelsa*, *Cedrus libanus*, *Thuja gigantea*, *Taxus baccata*. The following were uninjured: *Pinus sylvestris*, *P. Austriaca*, *P. strobus*, *P. mugho*, *P. humilis*, *P. inops*, *P. resinosa*, *P. serotina*, *P. cembra*, *P. edulis*, *P. Benthamiana*, *P. ponderosa*, and *P. Jeffreyii; Abies excelsa*, *A. nigra*, *A. Douglasii*, *Canadensis*, and *A. balsamea; Juniperus* (15 species, including the *Gossainthanea*); *Cupressus Lamsoniana* and *C. ericoides*, *Taxodium distichum*, (others failed); *Taxus adpressa* and *T. Canadensis* (others injured); *Thuja occidentalis*, *plicata*, *Siberica;* Hovey's and Buist's *Thujas*, *Ilex opaca*, *Laurus*, *Mahonia*, and *Thuyopsis borealis*.—(*J. Monell*, Saint Louis, Mo.)

KANSAS.

The timber area of Kansas is estimated by Mr. R. S. Elliott[1] at about 2,560,000 acres, or 4.92 per cent., chiefly in the eastern part of the State, the remainder being treeless, except as the rivers and streams are fringed with groves.

In 1870, the Farmers' Institute of the State Agricultural College prepared a list of trees as worthy of trial for cultivation in this State, embracing 24 kinds, viz: Ailanthus, ash, box-elder, catalpa, cedar, chestnut, coffee-bean, cottonwood, elm, hackberry, hickory, honey-locust, larch (European), linden, locust, maple (silver and sugar), oak, osage orange, pine, poplar, tulip-tree, black and white walnuts, and willows. It was believed that all of these would thrive in congenial conditions

[1] *Transactions of Kansas State Board of Agriculture*, 1872, p. 326.

in the eastern border; but it is probable that the list would be much reduced in going west, until toward the elevated regions bordering upon Colorado, irrigation would be indispensable to success.

In the order of preference, Mr. S. T. Kelsey[1] has placed the black walnut *first*, the cottonwood *second*, and the soft maple *third*, suggesting that the cottonwoods might be planted among the walnuts for their protection while young, and to secure an upright growth, to be thinned out from time to time as the trees become larger. He estimates the cost of planting and cultivating 25 acres of land in forest, as follows:

Breaking the prairie sod, at $4 per acre	$100 00
Gathering seeds, and cutting and growing plants	30 00
Re-plowing one-third of the ground, at $3 per acre	25 00
Harrowing for the rows of trees, and staking out rows	10 00
Planting, 25 days, at $2 per day	50 00
After-culture, first year, $1 per acre	25 00
After-culture, next three years, 50 cents per acre	37 50
Total	$277 50

This estimate contemplated planting in rows, 12 feet apart, and cultivating between for the first three years.

The success of tree-culture, as well as the cultivation of the cereals in Kansas, under existing conditions of climate, must depend very much upon the amount and distribution of the rain-fall. For data, we must for the most part depend upon recent records, the observations in but one case (Fort Leavenworth) extending more than forty years, and most of them scarcely a quarter of this period.

A summary of results, shows very clearly the decreasing rates as we go westward, and for convenience, the State has been, for this study, divided into three belts or regions running north and south across the State, and called the eastern, middle, and western belts. The shading off from one into the other is so gradual that a boundary-line must be arbitrary, but Fort Riley may be assumed as the western limit of the eastern belt, and the west line of Ellis County as the line between the middle and western. The aggregate results of over two hundred and fifty years of observations, to 1874 inclusive, will give the following general averages by months and seasons:

MONTHLY AVERAGES OF RAIN-FALL IN KANSAS.

Regions.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Eastern belt	1.35	1.73	3.01	3.15	4.82	4.94	5.03	4.30	3.36	2.56	1.98	1.84
Middle belt	0.79	1.75	1.12	2.12	3.18	2.69	3.40	1.79	3.29	1.38	0.65	1.45
Western belt	0.42	0.36	0.33	2.17	4.27	2.27	2.32	1.88	1.79	2.57	0.45	0.64
State at large	0.85	1.28	1.49	2.48	4.09	3.30	3.58	2.66	2.81	2.17	1.03	1.31

Variations from the mean of whole State.

Eastern belt	+.70	+.45	+1.52	+.67	+.73	+1.64	+1.45	+1.64	+ .55	+.39	+.85	+.53
Middle belt	−.06	+.47	− .37	−.36	−.91	− .61	− .18	−.87	+ .48	−.79	−.38	+.14
Western belt	−.43	−.92	−1.16	−.43	+.18	−1.03	−1.26	−.78	−1.02	+.40	−.58	−.67

[1] *Transactions of Kansas State Horticultural Society*, 1872, p. 146.

Average of the above by seasons and years.

Regions.	Spring.	Summer.	Autumn.	Winter.	Year.
Eastern belt	9.99	14.26	7.90	4.92	37.07
Middle belt	6.42	7.87	5.33	3.99	23.61
Western belt	6.77	6.47	4.82	1.42	19.48
State at large	7.73	9.53	6.02	3.44	26.72

Variations from mean of whole State.

Eastern belt	+2.26	+4.73	+1.88	+1.78	+10.35
Middle belt	−1.31	−1.66	−0.69	+0.55	− 3.11
Western belt	−0.96	−3.06	−1.20	−2.02	− 7.28

The average rain-fall in 1875 was 28.46 inches in the eastern, 22.39 in the middle, and 21.19 in the western belt, and for the State, 26.72. The influence of elevation is not taken into account. How far these conditions may hereafter be influenced by cultivation, remains to be ascertained by future observations. It is admitted, as a fact beyond denial, that the short, crisp "buffalo-grass," that covered the plains at first settlement, is giving place to a species of ranker growth—the blue-grass—more valuable for pasturage. As the prairies are brought under cultivation in taller grass, the hygrometrical conditions of the soil and climate appear to improve, although, from the absence of observations upon the wet and dry bulb thermometer, we have no data for stating the actual and relative humidity.

The process of slow self-planting in Central Kansas is thus described by Dr. L. Sternberg, in a paper read before the Kansas State Horticultural Society:

On many of the small streams there is a more dense growth of timber than when the country was first opened to settlement. The necks of creeks (having a narrow lining of timber), formed by their numerous windings, are being gradually covered with trees; and the shade and mulching afforded by these trees produces congenial conditions, under which numerous others are constantly springing up, and thus the timber area is enlarging. Sometimes additions are made to this area by a slow but sure process, viz: To furnish the necessary shade and mulching for the growth of tree-seeds, let the surface be covered with tall grass. From this condition will spring up some such shrubs as elders, or wild plums, but most commonly sumac. Then comes forth varieties of larger growth, from seeds, as the elm, ash, or box-elders, and other varieties may follow, and in a few years the latter kinds will overtop, and by their shade destroy, those that first gave them shelter, and hence the increase of forest area.[1]

Experiments tried in tree-planting in Central Kansas in 1859, with trees from Illinois nurseries, were not successful. In 1860, the season being dry, the result was no better, and in 1861, another dry year, the same experience followed. In 1862 plantations of native woods began to live, and with careful management it is now considered reasonably certain that trees can be started and made to thrive, and it is quite probable that this success is largely due to improved experience in planting, rather than to any change in conditions.

As in other prairie States, one of the first needs of timber is for fences, and until recently the fence-law in this State was most absurd, and quite in favor of the owners of stock. The State now has a herd law that appears well calculated to the wants of the State, and its application is left to the several counties. The following statistics have interest in this connection:

[1] *Transactions of Kansas State Horticultural Society*, 1875, p. 122.

Statistics of Fences in Kansas in 1875.

Kind.	Rods.	Total value.	Average value per rod.
Stone	703, 428	$1, 662, 792 00	$2 36
Rail	8, 550, 315	11, 436, 358 73	1 34
Board	2, 825, 116	3, 912, 969 29	1 31
Hedge	5, 822, 408	3, 019, 051 10	52
Wire	1, 205, 200	893, 220 00	74

From eight counties no returns were received, and from several others the returns were manifestly defective.

Tree-planting in Kansas—Suggestions by Mr. Kelsey.

Mr. Kelsey, in an essay read before the Kansas State Horticultural Society December 15, 1868, from an experience of twenty years in planting, of which six had been spent in Kansas, gave the results of his observation, especially with the black walnut, cottonwood, and silver maple, which he preferred as best adapted for this region. In planting black walnuts he directed they be gathered soon after they drop, and to be spread and covered two or three inches deep with moist earth, or, better, with sawdust, to keep them moist through the winter. They should be planted two inches deep, early in spring, and with fair soil and good cultivation they would grow so as to be of some use as fuel in five or six years, and in ten years would make good fence-posts or railroad-ties, and begin to bear nuts. In fifteen years they would make a fine forest, and if judiciously managed would go on increasing in value for a century, returning fair profits annually, and without expense. It should not be transplanted, but the seed should be placed where the tree is to stand.

Cottonwood might be started from shoots of last year's growth cut in the fall and packed in moist sawdust, or buried in the earth till spring. They should be a foot long and might be set with a narrow spade, leaving an inch or two out, and pressing the soil firmly about them at setting. Small plants with roots might be easily got; they would begin to be of service as wind-breaks and shelter for stock in four years, and the wood makes a fair fire-wood. He suggested planting cottonwood alternately with black walnut, to make the latter grow taller than if grown alone.

Silver maple should be started from seed, which ripens from the 15th to the 18th of May, and should be sown immediately in drills and covered with an inch of good mellow soil. It will come up in six to ten days, and by fall of the first year will be two feet and a half high. The next spring it should be set in forest rows, two inches deeper than it stood in the seed-bed, the earth being pressed firmly about the roots. In ten years it will be 25 to 30 feet high and 10 to 12 inches in diameter. It forms a beautiful tree while young, and its wood is more valuable than cottonwood, being useful for cabinet-wares. Its sap will make sugar of good quality, but less in quantity than the sugar maple. It has the fault of forking, so as to make two or more stems, and except in favorable circumstances is not likely, if left to itself, to make a large straight tree. It is also split down too easily by the wind and by sleet.

In planting a forest he recommended laying out the ground, after

[1] See this article in detail in *Hutchinson's Resources of Kansas*, p. 151.

plowing, into rows 12 feet apart,[1] setting the young plants 18 inches apart in the rows, and cultivating the ground between with corn until the whole surface was shaded. The walnuts might be planted with a hoe, like potatoes, and the cuttings and young plants with a spade. When the trees have grown so as to shade the ground too much he advised sowing with red clover, and, if hedged or inclosed, hogs or young cattle might be turned in to feed on the clover. But it is not advisable to pasture woodland with any animal that will injure the trees.

Among other trees adopted for growth in Kansas he mentioned the honey-locust, white ash, box-elder, Kentucky coffee, white, red and water elm, butternut, chestnut, hickory, cypress, European and American larch, linden, silver-leaf poplar, mulberry, catalpa, ailanthus, white and yellow willow, and hackberry.

Evergreens, always desirable as screens and often as ornament, grow slowly for the first few years until they become thoroughly acclimated. Much disappointment has been felt in the failure of these plants, especially when brought from distant nurseries and in bad condition. They should be got from nurseries near home while small, and preference should be given to those that have been several times transplanted. They should be set from the 1st to the middle of April, or earlier if the ground is in good order. The roots should be exposed to the sun and air *as little as possible.* The Norway spruce, white, Austrian and Scotch pines, balsam fir, red cedar, and American arbor vitæ, present advantages worthy of notice. The native evergreens from the West and South are especially worthy of trial on Kansas prairies in preference to exotic species.

The black locust in Kansas, as in very many places elsewhere, is very liable to injury from a borer. But this injury is less on dry limestone lands, and in the interior of large groves. When the trees are killed down sprouts will still spring up from the roots, and often reach a size suitable for poles or for fuel, before they are in turn attacked.

The great toothed poplar (*Populus grandidentata*) has been suggested as a desirable tree for cultivation in Kansas. It grows rapidly and to a large size, splits freely, and when cut and the bark peeled it will last quite well in the open air, when not in contact with the ground.

The State of Kansas exhibited at the Centennial of 1876, specimens of 44 deciduous and 2 coniferous woods grown within the State, and mostly native species.—(*Report of Managers*,—published by the State in 1877, p. 285.)

The following local items will serve to give an idea of the timber resources of various sections of the State:

Atchison County:

The bluff-land along the Missouri River is generally timbered with oak, black walnut, hickory, elm, cottonwood, &c., but the best timber is on the bottom lands, in the ravines, and on the islands. The poorest is on the tops of ridges and on the south and west sides of bluffs. It is often noticed that the north side of a bluff will have considerable timber, while the south side will be bare, showing that nature has had the same difficulty with hot suns and winds that have so much discouraged the planting of orchards and groves. This place is about 1,200 feet above tide; rains, 20 to 30 inches; winds in spring and autumn south and southwest, with a tendency to shift

[1] This is doubtless a great mistake. The first rows should be much nearer together, care being taken to thin out from time to time as they become larger, so as to admit more air and light to the trees as they become larger. If it is urged that the settler with slender means cannot afford to plant his ten or twenty acres with so many trees, the answer is ready, that by planting a given number on half the space he will have a greater final profit from increased growth afforded by mutual shelter in the earlier years, and a straighter and taller form.

suddenly and blow furiously from the northwest. In winter the winds are north and northwest. The planting is generally of soft maple, sycamore, black walnut, and cottonwood, on the prairies, with some sugar-maple on the bluffs; honey-locust is preferred by many, and some plant mulberry and wild cherry. Of trees not native, the ailanthus, Lombardy and silver poplars, Austrian, Scotch, and white pines are probably the only kinds that have so far shown a tendency to thrive, and even these, except the ailanthus, do better when partially protected from the hot suns on a south hill-side. The osage orange may prove a valuable timber-tree. The chestnut and larch have been largely planted, but have generally failed, probably from the dry atmosphere.

Small forests have been planted in this vicinity, and, when rightly managed, have been successful. The largest are not probably over 20 acres in a place. Cottonwood is generally used, with some walnuts, locusts, &c.

As to effect of forests upon climate, it is easily shown that their absence accelerates evaporation. The breaking of the wind-currents also has an effect easily observed but difficult to describe. The snow lies on the ground longer in the woods than on the prairies.

The black locust and mountain-ash are much troubled with borers, especially the former, but most insect damage is done by the grasshoppers.

Soft-maple seeds are gathered in May and planted before they get dry, in nursery rows. They may grow from 1 to 3 feet the first season and may be easily transplanted when two or three years old. Honey-locust seed should be scalded and planted in the spring, and this tree is easily transplanted. Cottonwood and willows grow easily from cuttings made in the spring. A good way is to take stakes or cuttings about 4 feet long and drive into the ground where they are to grow. They will grow as well as with roots, and the labor is less. Black walnuts should be planted where they are to remain. Their growth is very slow for a few years at first. Groves and forests should always be planted close, the trees, not more than 3 or 4 feet apart each way. They will need room as they get larger, and should be thinned out from time to time. Cottonwood, hickories, elms, sycamore, and walnut generally spring up where an old growth has been cut off, and extend into prairie-land where the fires are kept out. —(*E. Snyder*, Atchison, Kans.)

Cloud County:

I have been very careful, in making up my report in regard to artificial forest-tree culture in this county, to get as near the correct amount set out as possible, and I am happy to say that the culture of forest-trees is most encouraging. From careful inquiry and observation, I find that there are in this county about 2,350 acres of artificial forests. The last two years (1875, 1876) have been very encouraging to the grower of forest-trees, as they have made such a rapid growth, and the autumn being so long and favorable, the wood matured. There have been a number of claims taken in this county under the timber-culture act, but I don't believe one person in twenty will ever comply with the requirements of the law. In fact, the law as it now stands is a farce, and the dearest way a man can get land, provided he *does* fill the law; but they hardly ever attempt to fill the requirements of the law. I think it would be very desirable if the law could be changed so as to put out trees for timber-belts for the protection of the whole farm, or put out a given number of trees on a quarter-section; but where a man attempts to put out forty acres of timber on a quarter-section, and cultivate as it should be, he has got more on his hands than he can do successfully.—(*C. H. Sheffield*, Glasco, Kans.; State Hort. Report, 1876, p. 127.)

Coffey County:

Of evergreens, the Austrian pine and red cedar suffered the least injury in 1874. * * * The flat-headed borer breeds in the apple, pear, cherry, plum, haw, and maple, and in the spring of 1875, was most destructive to the apple and maple trees. The round-headed borer has not yet damaged our trees, and is seldom found. I have never found a flat-headed borer in trees leaning to the southwest, nor have I known of their eggs hatching in a sound, healthy tree. * * * In a nursery one mile west of me, the rows running north and south, have not been troubled with borers, and no unusual protection has been used. * * * From the poles used for supports of our grape-vines, such as the walnut, mulberry, red bud, and oaks, there come forth several kinds of beetles, but none of them were of the species attacking fruit-trees. * * * There cannot be too much importance attached to the matter of protecting trees from the direct rays of the summer's sun, and it does appear that leaning the bodies to the southwest is one of the most reliable means. *Root-lice.*—These insects, especially destructive to grape-vines, threaten to be annoying in this county unless promptly checked. I have found them on the roots of apple, pear, cherry, grape, and evergreens.—(*W. W. Tipton*, Burlington, Kans.; State Hort. Report, 1875, p. 146.)

Dickinson County:

A few of our citizens have planted wind-breaks with success. The first settlers in the town of Cheever organized an arboricultural society in the spring of 1872, and

the magnificent growth of timber in this town bears testimony that the labors of this society have not been in vain. The question as to whether trees will grow on treeless plains has been settled beyond dispute. Nearly twenty-five acres have been planted, not including timber claims, in this town alone. The following list of trees has been fully tested, and has succeeded admirably in this section, viz: white ash, white elm, slippery elm, honey-locust, yellow and black locust, box-elder, white maple, balsam-poplar, Lombardy poplar, cottonwood, and black walnut. Of evergreens, the red cedar, Austrian, Scotch, and mountain pines.—(*J. W. Robson*, Cheever, Kans.; State Hort. Report, 1876, p. 129.)

Douglas County:

The most successful, and therefore most satisfactory deciduous tree for ornamental planting, is the white elm. The silver maple has been denuded twice each year for the past three years by what is termed the "*maple-worm*," and is therefore not satisfactory. The catalpa, ailanthus, cottonwood, sycamore, box-elder, black walnut, gray ash, and mulberry have been planted, most satisfactory of which are the ash, sycamore, and mulberry, all of which bear transplanting well. Scotch, Austrian, and white pine, balsam-fir, Norway and white spruce, American and Siberian arbor vitæ, Irish junipers, red cedar, and European silver fir have been planted at all ages up to twelve years old, or even older. The red cedar is the hardiest, and is grasshopper proof. The Scotch and Austrian pines are the next hardiest, but do not stand the hoppers. The fir and spruce family we take under advisement for future and further trial. Not a great amount of timber-planting in this county, and that mostly silver maple and cottonwood. The above is for that part of Douglas County east and south of Lawrence.—(*G. Y. Johnson;* State Hort. Report, 1874, p. 207.)

The American and European ash, *Ailanthus glandulosa*, and catalpa were planted as early as 1858, age varying from two to four years at time of planting. Have been cultivated with spade and hoe, and are in thrifty condition at this date. The European larch were planted in 1861; do not know their age, but were 2 or 3 feet high; obtained from Indiana; reached a height of 10 to 15 feet in 1873, when the hot spell in August killed them. Evergreens were planted in the spring of 1861. The height of Norway spruce, American and Siberian arbor vitæ, Scotch pine, Austrian and white pine was 2 feet; reached the height of 10 to 15 feet in 1874, and were killed by the drought and grasshoppers. A heavy mulch kept constantly around them was all the attention given. They made a very heavy, strong growth. The red cedar, planted at the same date, and of the same size, made a satisfactory growth, and at this date seems unimpaired by drought or hoppers. It proves worthy of the name "iron-clad." The cost of these trees at the time of planting averaged thirty cents each. *Timber and forest trees.*—Black-locust seeds were sowed in the spring of 1858, in rows 4 feet apart, 2 or 3 inches apart in the row; were cultivated with the hoe the first year, and the plow for four years, when cultivation ceased. They have been ruined by borers. Cost of seed 80 cents a pound. The black walnut was sown upon upland in the autumn of 1861, in rows 6 feet apart, and 1 foot in the rows; cultivated with hoe and plow three years, and made a fair growth; after cultivation ceased gradually failed, and are now worthless. Silver-leaf maples were bought at Hermann, Mo., in the spring of 1861, one year old, at a cost of one cent each, cultivated in nursery rows for three years, then planted in groves and wind-breaks, and cultivated with plow; have done well. In groves on some soils they have suffered from borers, but generally are very healthy, and making a good growth. Cottonwoods were planted as early as 1856 and 1857. Young seedlings were taken from the river forest, 3 or 4 feet high; have outgrown all other varieties; many are over 1 foot in diameter—some will measure 18 inches; are healthy, hardy, and free from disease and insects. White willow, that once-famous fence and timber tree, which was "for the million," was bought in Illinois, in cuttings, at $3 per thousand, and planted, in the spring of 1862, in fence-rows, belts, and groves; grew well in some localities as belts and groves, but did not prove very admirably adapted to making fence-rows. Most of the plantings have failed, but very few ever giving, if they did at all, satisfaction. Since the first attempts as above stated, there has been scarcely any variety used in Douglas County but elms and silver-leaf maples, and these have been dug in the forests or grown from seed obtained from trees along our streams. The cottonwood has been objected to on account of the innumerable amount of seed it scatters; the elms on account of slow growth, and the maple for its disposition to fork and then split; but what tree has not some faults? There has been no planting in this county exclusively for fuel or timber purposes; yet I am satisfied that had such a planting been made at an early day profitable results would have crowned the enterprise.—(*G. C. Brackett*, Lawrence, Kans.; State Hort. Report, 1874, p. 211.)

Maj. W. C. Ransom, of Lawrence, Kans., in a report of his experience on ornamental trees, states that he, some years ago, imported fine specimens of the Japan cedar, Mount Atlas cedar, cedar of Lebanon, Deodor, Nootka Sound cypress, and quite a number of the finer varieties of *Retinospora* (Japan cypress), and Chinese and other Asiatic varieties of the juniper. They were received in fine condition, and well cared for, but

all died. Some were again tried, two or three years after, but with no better success, and the same fate occurred with firs from the Rocky Mountains and the Sierra Nevada. Lauton's cypress, and *Seqvioa gigantea* grew, but did not ripen their wood. In fact, his list of evergreens on which expectation could be founded was reduced to three: the Austrian or black pine, Scotch pine, and red cedar, the latter being native, hardy, and reliable. Of deciduous trees he placed first the elm. If soft maples were planted, they should be headed back. The ash did not appear to thrive. The larch could not maintain its erect habit against the winds, unless planted in low grounds and with other trees. The deciduous cypress and the gingko had done well in the vicissitudes of Kansas climate and defoliation by grasshoppers.—(*Transactions of Kansas State Hort. Soc.*, 1875, *p.* 222.)

FRANKLIN COUNTY:

The trees usually planted are the elm, sycamore, soft maple, ash, black walnut, &c., that are native, and the red cedar, Norway spruce, white, Austrian, and Scotch pines, which are introduced, and are found to thrive. The arbor vitæ, hemlock, and larch have not generally been found successful. The soft maple has been extensively planted, but for the last few years they have for a considerable part of the summer been infested with a worm that has caused great damage, and has discouraged further attempts at planting. The elm is in a few cases infested with the oyster-shell bark-louse. Perhaps thirty or forty acres of timber-trees have been planted on the farm of the Ottawa University, consisting of soft maple, black walnut, catalpa, ailanthus, cottonwood, and in less quantities, red cedar, white pine, Lombardy poplar, &c. The amount of timber in this section appears to be increasing.—(*A. Willis*, Ottawa, Kans.)

LYON COUNTY:

P. G. Hallberg has evergreens growing on his grounds adjoining Emporia of the following varieties and ages, which he values in the order in which they are named: Austrian pine, 16 years; Scotch pine, 16; red and white cedar, 16; juniper, 16; balsam-fir, 16; white pine, 10; Norway spruce, 10; arbor vitæ, 10; hemlock, 4. All these varieties stood the drought of last summer, and came out all right.—(*J. M. Miller*, Emporia, Kans; State Hort. Report, 1874, p. 218.)

Mr. Miller, in reply to circular of the department, gives the following additional information:

Our timbers, mentioned in the order of value, are black walnut, burr oak, hickory, hackberry, white ash, cottonwood, white and red elm. The first is at present, and prospectively, altogether the most valuable. Where old forests are cleared off and the land left, there soon springs up a dense undergrowth of these various kinds of timber, and with such a supply to begin with, we would soon have enough, if fires are kept out. The osage orange and honey-locusts are valuable.

MIAMI COUNTY:

Cedar trees were set out at a very early date, and seemed to do well in almost all locations. In the spring of 1861, white Austrian, Norway, and Scotch pines were set out, also balsam and arbor vitæ. All have done well until the present season, when the drought destroyed the balsams and arbor vitæs. The pines are all alive, are from 15 to 22 feet high, and cone-shaped from the ground. The grasshoppers stripped the Scotch and Austrian pines of nearly all their foliage, while the white and Norway were not injured. This county being one of the best-timbered in the State, forest-culture has received but little attention. Native forest-trees have all done well, I believe, except soft maples, and they are being dug up where planted, on account of a worm which has stripped the tree of its foliage for four years past.—(*C. S. Adair*, Ossawatomie, Kans.; State Hort. Report, 1874, p. 220.)

MITCHELL COUNTY.—Three-fourths of the fruit trees of the county have been destroyed by borers, rabbits, or sun-scald. Soft and silver-leaf maples, aliantus, and catalpas have been successfully grown as ornamental trees. We have poor success with all evergreens. Box-elder, red and white elm, white ash, coffee-bean, cottonwood, soft maple, and black walnut have been planted with good success when the ground has been thoroughly plowed before planting and when there has been reasonable after-culture. The above varieties of trees are offered for sale in this locality at from $5 to $7 per 1,000, one year old. Box-elder, ash, and soft-maple seed can be bought for $2 a bushel. The elm, cottonwood, and coffee-bean would cost $6 to $8 per bushel. No damage has been done the box-elder, ash, coffee-bean, or black walnut, by rabbits, grasshoppers, or insects. The elm, cottonwood, and maples are browsed by grasshoppers and rabbits, but not seriously injured. Box-elder, ash, and coffee-bean, are considered the best for extensive planting.—(*E. A. Taylor*, Beloit, Kans; State Hort. Report, 1875, p. 162.)

Morris County.—Ornamental trees and shrubs also failed (1874), or at least were killed to the ground. The buds showed weakness in their development and the wood growth was small during the season as compared with other years. This weakness was only among plants and trees which were defoliated the previous autumn by the locusts. Such trees as escaped their attacks developed their buds, and the growth of the season was equally strong and healthy as in other years. Generally the fruit trees did not bloom, the buds being destroyed by the "hoppers" in previous fall. * * * The red cedar passed safely through the test of the past year, and is deserving of a general recommend. It bears any amount of trimming, and can be made very ornamental for hedges, belts, groups, or singly. Balsam-fir is quite hardy and a fine grower. The spruces, arbor vitæ, and the numerous varieties of pines must be protected from the locusts, or they will be destroyed.—(*L. M. Hill*, Hill Springs, Kans; State Hort. Report, 1875, p. 163.)

Neosho County.—Of evergreens I have 350, viz, Austrian, Scotch and white pines, red cedar, Norway spruce, Irish juniper, balsam-fir, and American arbor vitæ, ranging in size from 4 to 7 feet. In the growing of evergreens I have been very successful, until the last ravages of the grasshoppers. They can be grown with sufficient care in handling. Out of 168 set in 1875 but four died. The moment the little fibers become dry, that moment the evergreen is dead to all intents and purposes. The same is true whenever an evergreen, after being transplanted, is blown about by these Kansas winds until the dirt is pressed away from around the body, allowing the air to get in between the roots of the tree and the dirt. I believe as many trees are killed in this way as any other. I have plenty of sawdust around each tree, so that in case the tree should move about, the sawdust will work into any crevice that may be made. * * * The American arbor vitæ I have failed to keep alive longer than three years from the time of setting out. The Irish juniper does not live any longer. The Norway spruce does well if it it was not for the grasshoppers; they seem to prefer this to all other kinds, having killed quite a number for me. The balsam-fir does well, but it is a great favorite with the grasshoppers. My white pines are looking splendidly, as also my red cedars. Many of the white pines about me have been badly injured by grasshoppers. The savin flourishes finely, but the evergreen that does best with me, and, I may add, the only one that grasshoppers never molest, is the Austrian pine. It is usually considered one of the hardest varieties to make grow, yet I have never lost one, so that I have about concluded that had I an order to make for 100 evergreens, I should write thus: "Seventy-five Austrian pine, and the remaining twenty-five Austrian pine also."—(*H. H. Jackson*, New Chicago, Neosho County, Kansas; State Hort. Report, 1875, p. 51.)

Sedgwick County.—Protections are very important to the horticulturist. Rapid-growing forest trees around the farm, the orchard, stock-yards, and buildings, not only afford protection and shade, but are also ornamental and attractive. Cottonwoods prove the most successful of any I have tried for such purposes. They grow rapid and stocky, and resist the force of wind equal to the sturdy old oak. The peach is one of the best trees for wind-breaks and fuel. They are rapid growers, and, after three years old, may be thinned out from year to year, thus furnishing fuel of the best quality. It will also give yearly crops of fruit, not uncommonly of good character. A good way to plant is to prepare the ground in the fall, as for corn, open furrows, 10 feet apart, and drop the seed three or four inches apart in them, and cover them with a furrow turned on them from each side. In the spring, pass the harrow over the rows. This will kill all weeds starting and give the young plants a good opportunity to get a start.—(*A. J. Cook*, Wichita, Kans.; State Hort. Report, 1874, p. 230.)

Shawnee County.—For deciduous ornamental trees, the catalpa and ailantus perhaps are most desirable. But when the elms, box-elders, white ash, soft and sugar maples have been planted for eight or ten years they have proven a success and given satisfaction. Some, however, object to the soft maple on account of liability to defoliation by the maple-worm. I measured the following-named varieties, planted when two years old and are now eight years old from planting, and found, at the collar, soft maple, 15 inches in diameter; sugar-maple, 6 inches; white ash, 9 inches; wild cherry, 11 inches; box-elder, 8 inches; catalpa, 7 inches, and ailantus, 9 inches. *Evergreens.*—I find nothing very flattering in any of them. Most of the largest ones were ruined by the grasshoppers the past summer. A few Austrian pines, red cedars, and Irish junipers escaped. These make a very moderate growth. All the rest have proved poor cumberers of the ground. *Forest trees.*—I find some cottonwood trees making 15 inches diameter in eight years. I believe, for most forest culture, that the cottonwood, walnut, white and red elm, soft and sugar maples, locust, Osage orange, hackberry, coffee-bean, wild cherry, and box-elder are well adapted to this climate. Some of them will not bear transplanting. The seeds must be planted where they are to stand.—(*A. A. Ripley*, Topeka, Kans.; State Horticultural Report, 1874, p. 230.)

NEBRASKA.

A general outline of the native timber resources of the region now included in this State, is given by Mr. James T. Allan, in a letter printed in the American Journal of Science in 1861.[1] It is applicable to the region west of the Missouri, between the parallels of 40° and 43° of latitude.

One remark will apply to all this country, that timber is found only upon streams or in small groves about some spring on the wide prairie.

The valley of the Missouri is from 3 to 6 miles wide, and sometimes the stream winds down the center with both sides fringed with willows, behind which is a belt of cottonwood (*Populus monilifera*); these trees often 80 to 100 feet high. Upon the bluffs which wall each side of this valley we find the different varieties of hard wood; also upon the hills and ravines opening toward the river. On the tops of these hills we find *Quercus alba* and *rubra*, with occasional trees of *Q. coccinea;* half way down the steep sides of these ravines we find *Tilia Americana* and *Ulmus fulva* in about equal quantities, with clumps of *Carpinus Americana.* Still lower down, and in the rich soil at the bottom, are *Gymnocladus Canadensis, Celtis occidentalis,* and *Fraxinus Americana;* while on the cool northern slope, half hanging down the hill, are plenty of *Staphylea trifolia* and *Rubus occidentalis.* As we recede from the river toward the summit of the ridge we find scattering trees of the *Carya alba* among the oaks before mentioned, till we come to the prairie, where the trees terminate with a few "scrub oaks," 12 to 20 feet high, standing beyond the fringe of *Corylus Americana.* Among the latter, in the spring, we discover the bright blossoms of the red-bud (*Cercis Canadensis*), and in the autumn the bright seed-pods of the *Euonymus.*

Going west from the Missouri we find no trees except on the small streams, on which, at intervals of ten miles or more, are groves of white oak, burr-oak (*Carya glabra*), and sometimes white elm. These groves will average in extent from 100 to 500 acres, and the above mentioned, with *Juglans nigra*, make up their prominent trees.

The valley of the Platte, to which so much attention is now directed as the great central route, demands a notice. At the mouth we find a heavy body of timber, chiefly cottonwood, with a small proportion of *Acer rubrum* and *Morus rubra.* As we proceed up twenty miles the dull green of the *Juniperus Virginiana* begins to be seen, which, farther up, we see covering some of the small islands with trees often 18 inches or more in diameter. This has furnished, for a hundred miles or more, telegraphic poles of a superior quality.

Upon the tributaries of the Platte, particularly on the north side, *Quercus macrocarpa* is the most abundant of large trees. After leaving Fort Kearney, the immigrant finds but a fringe of cottonwoods skirting the stream, and on the road to the new gold mines, for 200 miles, not a tree for shade or wood; the well-known "buffalo-chips" must supply the latter. Upon the North Platte, the emigrant to California, or to the Mormon "Zion," is always in sight of trees bordering on the stream, though found in several places large groves of *Negundo aceroides* on the banks of the creeks.

After passing Fort Laramie the pleasant sight of green pines, though at a distance, relieves the eye and tells of the cool waters in the South Pass, so refreshing in the heat of summer.

The very rapid growth of trees in this rich soil is a noticeable feature. The hazel, which fringes the timber on the prairie side, is interspersed with abundance of saplings of *Carya alba* and *glabra* and *Alnus fulva*, which shoot up with wonderful rapidity, while upon the sand-bars of the river, as soon as the waters subside in July, there springs myriads of young cottonwoods and willows. Of the latter I have neglected to speak, though they cover no inconsiderable portion of the valleys of the Missouri and Platte, everywhere fringing the streams, and where there is a tract annually overflowed by the spring rise there we find a dense growth, often 20 to 30 feet high and from 1 to 3 inches in diameter, growing so thickly that it is impossible, without great difficulty, to force a passage through them.

The relative proportion of the several species may, perhaps, be set down as follows:

1. *Populus monilifera.*
2. *Quercus macrocarpa.*
3. *Quercus alba* and *Q. rubra.*
4. *Tilia Americana, Ulmus fulva*, and *Quercus discolor.*
5. *Juglans nigra, Ulmus Americana.*
6. *Carya alba, C. glabra.*
7. *Fraxinus Americana, Celtis occidentalis.*
8. *Juniperus Virginiana, Platanus occidentalis.*
9. *Acer rubrum, Gymnocladus Canadensis.*

---

[1] Letter to Professor Gray, dated Omaha, April 2, 1861, *Am. Jour. Sci. and Arts*, 2d ser., xxxii, p. 165.

Besides the above mentioned, of the smaller varieties there are *Prunus Americana, Zanthoxylum Americanum, Staphylea trifolia, Negundo aceroides, Corylus Americana, Carpinus Americana, Alnus incana, Euonymus Americana, Cercis Canadensis, Cornus sericea* (?).

In the Omaha land district, which contains something like 4,000 square miles of land, there appears from the plats in the office to be about 75,000 acres of timber. A tract of country of equal size lying west of it would contain much less.

It appears evident that within a geological period comparatively recent, timber grew in portions of Nebraska now entirely destitute of native forests. Professor Aughey found, in 1868, in a peat-bog in Cedar County, a log, buried in the bog, at least 60 feet in length, and many more of various sizes. The roots of pine trees are often found sticking from the ground along the Niobrara River, on the northern border of the State, more than 50 miles distant from the nearest present forests. The cause of disappearances affords a theme of conjecture, but it may fairly be ascribed to destructive summer fires in exceptionally dry seasons, and the charred appearance of the roots appears to confirm this theory, which is further supported by obscure Indian traditions. There are also indications of a greater amount of rain-fall at a former period, and the dryness of modern years may have had some connection with this sweeping away of great forest areas.

In speaking of the possibility of re-establishing a forest growth in this region, Professor Aughey remarks:

It is wonderful how nature here responds to the efforts of man for reclothing this territory with timber. Man thus becomes an efficient agent for the production of geological changes. As prairie fires are repressed and trees are replanted by the million, the climate must be still further ameliorated. When once there are groves of timber on every section or quarter-section of land in the State, an approach will be made to some of the best physical conditions of Tertiary times.[1]

Comparison of the floras of Nebraska and Iowa so fas as they relate to wood-bearing species.

A catalogue of the flora of Nebraska by Professor Aughey,[2] and one of Iowa by J. C. Arthur,[3] show the following points of resemblance and difference. For convenience of reference, the lists are arranged alphabetically.

I.—FOUND IN BOTH STATES.

Acer rubrum (*red, or soft maple*).
  saccharinum (*sugar maple*).
Æsculus flava (*sweet buckeye*).
  glabra (*Ohio buckeye*).
Alnus incana (*speckled alder*).
Amelanchier Canadensis (*shad bush*).
Amorpha fruticosa (*false indigo*).
Ampelopsis quinquefolia (*Virginia creeper*).
Asimina triloba (*pawpaw*).
Betula papyracea (*canoe birch*).
Carpinus Americana (*blue beech*).
Carya alba (*shellbark hickory*).
  amara (*bitter nut*).
  tomentosa (*mocker nut*).
Celastrus scandens (*bitter sweet*).
Celtis occidentalis (*hackberry*).
Cephalanthus occidentalis (*button bush*).
Circis Canadensis (*red bud*).
Cornus alternifolia (*alternate-leaved dogwood*).
  asperifolia (*rough-leaved dogwood*).
  paniculata (*white-fruited dogwood*).
  sericea (*Kinnikinnik: silky dogwood*).
Coryllus Americana (*wild hazel nut*).
Cratægus coccinea (*scarlet thorn*).
  tomentosa (*black thorn*).
Diervilla trifida (*bush honeysuckle*).
Euonymus atropurpureus (*burning bush*).
Fraximus Americana (*white ash*).
  quadrangulata (*blue ash*).
  viridis (*green ash*).
Glediscchia triacanthos (*honey locust*).
Gymnocladus Canadensis (*coffee tree*).

[1] *The Superficial Deposits of Nebraska*, 2d edition, p. 28. From Hayden's Geological Report for 1874.

[2] *Catalogue of the Flora of Nebraska*, published by the University of Nebraska, adapted for marking desiderata in exchange of specimens. Prepared by Prof. Samuel Aughey, Ph. D. Lincoln, 1875, 8vo., pp. 37.

[3] *Contributions to the Flora of Iowo.* A Catalogue of the Phænogamous Plants Prepared by J. C. Arthur. Charles City, 1876, 8vo., pp. 43.

Juglans nigra (*black walnut*).
Juniperus communis (*juniper*).
Virginiana (*red cedar*).
Lonicera flava (*yellow honeysuckle*).
Morus rubra (*red mulberry*).
Negundo aceroides (*box-elder*).
Platanus occidentalis (*sycamore*).
Populus monilifera (*cottonwood*).
Prunus Americana (*wild plum*).
Pennsylvanica (*wild red cherry*).
Prunus serotina (*black cherry*).
Virginiana (*choke cherry*).
Quercus alba (*white oak*).
bicolor (*swamp white oak*).
coccinea (*scarlet oak*).
macrocarpa (*burr oak*).
nigra (*black jack*).
obtusiloba (*post oak*).
palustris (*pin oak*).
prinus (var. acuminata) (*yellow chestnut oak*).
rubra (*red oak*).
Rhus aromatica (*fragrant sumac*).
glabra (*smooth sumac*).
toxicodendron (*poison ivy*).
typhina (*staghorn sumac*).
Ribes cynosbati (*prickly gooseberry*).
florida (*wild black currant*).
rotundifolia (*smooth gooseberry*).
Robinia pseudacacia (*black locust*).
Rosa blanda (*early wild rose*).
Rubus occidentalis (*black raspberry*).
strigosa (*red raspberry*).
villosus (*blackberry*).
Salix cordata (*heart-leaved willow*).
discolora (*glaucous willow*).
humilis (*prairie willow*).
longifolia (*long-leaved willow*).
nigra (*black willow*).
tristis (*dwarfgrey willow*).
Sambucus Canadensis (*common elder*).
pubens (*red-berried elder*).
Smilax hispiola (*greenbrier*).
Spiraea opulifolia (*nine bark*).
salicifolia (*meadow sweet*).
Staphylea trifolia (*bladder nut*).
Symphorocarpus occidentalis (*wolfberry*).
Tilia Americana (*basswood*).
Ulmus Americana (*white elm*).
fulva (*red, or slippery elm*).
Viburnum lentago (*sheep-berry*).
pubescens (*downy arrowwood*).
Vitis cordifolia (*winter grape*).

II.—FOUND IN IOWA AND NOT IN NEBRASKA.

Acer dasycarpum (*silver leaf maple*).
Betula nigra (*red birch*).
Carya olæviformis (*pecan*).
Diospyros Virginiana (*persimmon*).
Dirca palustris (*leather wood*).
Fraxinus sambucifolia (*black ash*).
Juglans cinerea (*butternut*).
Ostrya Virginica (*iron-wood*).
Pinus strobus (*white pine*).
Populus grandidentata (*large-toothed aspen*).
tremuoides (*American aspen*).
Pyrus coronaria (*crab apple*).
Quercus imbricaria (*laurel oak*).
Rhamnus lanceolatus (*narrow-leaf buckthorn*).
Salix petiolaris (*petioled willow*).
livida (*livid willow*).
Sasafras officinale (*sassafras*).
Taxus baccata (var. Canadensis) (*yew*).
Vaccinum vaccillans (*Low blueberry*).
Viburnum pubescens (*Downy arrowwood*).
Vitis riparia (*frost grape*).

III.—FOUND IN NEBRASKA AND NOT IN IOWA.

Abies Engelmannii (*Engelmann spruce*).
Douglasii (*Douglas spruce*).
Alnus serrulata (*smooth alder*).
viridis (*green alder*).
Betula pumila (*dwarf birch*).
occidentalis (*western birch*).
Carya porcina (*pig nut*).
Cercocarpus parvifolius (*mountain mahogany*).
Cornus circinata (*round-leaved dogwood*).
pubescens (*downy dogwood*).
stolonifera (*wild red osier*).
Coryllus rostrata (*beaked hazel-nut*).
Cupressus thyoides (*white cedar*).
Euonymus Americanus (*burning bush*).
Fraxinus pubescens (*red ash*).
Gleditschia monosperma (*one-seeded honey locust*).
Lonicera grata (*sweet honeysuckle*).
hirsuta (*hairy honeysuckle*).
involucrata.
Morus alba (*white mulberry*).
Pinus ponderosa (*heavy yellow pine*).
Populus angulata (*angular twig poplar*).
balsamifera (*Balm of Gilead*).
Prunus Chicasa (*Chickasaw plum*).
pumila (*dwarf cherry*).
Quercus castanea (*chestnut oak*).
prinoides (*chinquapin oak*).
Rhamnus alnifolius, (*alder-leaved buckthorn*).
Rhus copallina (*dwarf sumac*).
Ribes hirtellum.
lacustre.
aureum (*Missouri currant*).
Rosa Carolina (*swamp rose*).
lucida (*dwarf wild rose*).
setigera (*climbing wild rose*).
Rubus triflorus (*dwarf raspberry*).
Salix angustata.
candida.
pedicellaris.
rostrata.
Shepandia argente (*buffalo berry*).
canadensis.
Smilax glauca.
rotundifolia.
Ulmus alata (*whahoo*).
racemosa (*corky white elm*).
Vaccinum cæspitosum.
oxycoccus (*small cranberry*).
Vitis aestivalis (*summer grape*).
Wistaria frutescens (*American wistaria*).

By a resolution of the State Board of Agriculture, adopted January 8, 1874, the second Wednesday of April of each year, was dedicated and set apart as *Arbor Day* for the State of Nebraska, and a petition was addressed to the legislature asking that it be made a legal holiday. Although this legal sanction has not been given, the people of the State have very generally accepted the appointment, to be observed by planting forest, fruit, and ornamental trees. It is claimed that over twelve millions were planted in 1874. According to the returns of the assessors of that year, there had been planted prior to that date 2,017,537 forest and 52,193 fruit trees, and 56,856 rods of hedge. As there was no law requiring these returns to be made, and as no blanks were furnished, these statistics have not since been generally reported, although statements made from certain counties afford some basis of estimates.

Much has been done in this State, through associated effort, by the State Board of Agriculture and the State Horticultural Society, as the frequent citations in the following pages will show:

Premiums have been offered by various societies and by individuals for the planting of hedges, fruit trees, and groves of forest trees, regard being generally had to greatest amount at cheapest rates. The statements of applicants were to be verified by witnesses, and were to show the kinds planted, distance apart, mode of preparing the ground and of planting and cultivating, the number of trees living and dead, and the cost of trees and of labor. The premiums have generally been paid in agricultural books or periodicals, to be selected by the successful applicants from a price-list furnished.

At the January meeting of the State Horticultural Society in 1873, Mr. J. T. Allan was appointed to procure from the Rocky Mountain region a car-load of evergreen trees of the kinds that the society had procured specimens of two years before, and which had proved successful. These were to be distributed in various parts of the State to members of the society and others who would take proper care of them, and agree to report the result to the society at its next January meeting. The trees were to be distributed gratuitously, not more than a hundred to one person, and those receiving were to pay a *pro-rata* share of the expense.

We have seen no published report, and are not aware that returns as to success or failure were generally made. Mr. Allan, in a personal interview a few months since, estimated that about half of them were living.

In respect to the success that may, under good management, be expected to result from tree-planting in Eastern Nebraska, the following extract from an address delivered before the State Board of Agriculture, by the Hon. J. Sterling Morton, January 26, 1876, lays down his rules and mentions his results as follows:

First, the original sod should be broken and turned over in thin, evenly laid strips. When completed, a good breaking will appear, like a vast floor of well-laid two-inch plank painted with lampblack. Then plant and cultivate, not to see *how much* you can manage, but *how well*. Then come trees: walnuts, cottonwoods, willows, mulberries, and elms will make the home seem civilized. Tree-planting is an avocation which barbarians never follow. Indians never adorn their wigwams with orchards, nor indulge in floriculture. There is no record of an aboriginal horticulturist in any book I have read or heard of anywhere. It may seem a long time to raise a saw-log from the walnut which lies in the palm of your hand, but the rain and frost of winter and the sunshine of summer, together with the fertile and forcing soil of Nebraska, crowd a walnut into the dimensions of a respectable saw-log in less than twenty-five years. Upon a farm where I have lived, in Otoe County, for more than twenty years one may see black-walnut trees, which will make good railroad-ties, and some which will do to saw up, which I planted with my own hands. * * * And, again, there may be found

cottonwood saw-logs growing there which are more than six feet in girth, and when I first saw them they were only wandering germs, floating in the air like down from a bird's breast. But they are adult saw-logs in 1876. These remarks, somewhat egotistical though they may be, are made for the purpose merely of impressing you, and through you the farming people, with the tree-possibilities of this State, and I only preach in this regard what I have faithfully put in practice, and the witnesses of the truth of my theories stand majestically verifying me all over the farm whence this is written to you, in the form of beautiful, thrifty, and valuable fruit and forest trees. Come down and see them, and in the hot summer days, while you rest in their shade, even their foliage will tell you in whispering with the wind how pleasant and profitable a thing it is to plant the prairie with trees.

The following statements refer to particular counties in Nebraska, but doubtless apply in many instances to large districts of country adjoining:

Buffalo County.—In forest-planting most farmers have made a beginning, having planted from one to ten acres each. Some have surrounded their quarter-sections with rows of trees; others have used trees to divide the quarter into 80's; while others have fenced off each forty acres with rows of trees. Our farmers need education and experience. Our native cottonwoods will grow almost anywhere; but when alone it grows so rapidly that the wood fails to ripen, and is liable to winter-kill. But the young trees are amply proceeted when we raise with them some other crop. We have not had much success with soft maples, chestnut, or oak, but the black-walnut is thifty.—(*Trans. Nebr. St. Hort. Soc.*, 1877, p. 85.)

Burt County.—In hedging, Osage-orange has not proved a success, and better results have been had with willow and soft maple. The favorite hedge-plant so far, however, is the honey-locust, which is thought to be the best hedge-plant. About 2,500 acres of forest trees are planted in this county, mostly cottonwood, with a sprinkling of soft-maple, black-walnut, elm, and willow.—(*Trans. Nebr. St. Hort. Soc.*, 1877, pp. 71, 86.)

Clay County.—There are many groves of forest trees, a considerable number of which will reach from 3 to 20 acres, and where cared for they are in good condition. The cottonwood and box-elder stand pre-eminent, and the success achieved demonstrates that the prairies may in a few years be dotted with fine groves of timber. There has been no systematic hedge-planting in Clay County.—(*Trans. Nebr. St. Hort. Soc.*, 1877, p. 83.)

Douglas County.—William Hollenbeck had, in 1873, a grove of about 200 acres planted in 1861, in which the white ash measured 26 inches in girth and were 30 feet high. They were planted very closely and grew very straight, and free from lower limbs, and at an early age would arrive at a size valuable for farm purposes and manufactures. A fair average tract of 4 acres of black walnut, planted in 1865, measured in 1873 twenty-two inches around and 25 feet high. Some bore nuts in 1869, and quite a number a peck or more in 1871.—(*Fourth Rep. Board of Ag.*, 1873, pp. 426, 427.)

Fillmore County has 3,360 acres of planted timber, or 3½ to each farm of 160 acres. Of this 2,000 are cottonwood; 1,000 ash and box elder; 350 in soft maple, honey-locust, and black walnut; and the rest fancy varieties. This estimate does not include hedges nor the plantings of the Burlington and Missouri River Railroad Company. In the spring of 1877 it was expected that 1,500 to 2,000 acres would be set under timber-claims. All native kinds, except soft maple, thrive on the table-lands. The thornless honey-locust is growing in favor, the tree being of rapid growth and making good timber. This county has 75 miles of Osage hedge, 32 miles of willow, and 20 miles of honey-locust; but ignorance of the best methods of cultivation (and probably also the fact that the soil is new and not perfectly subdued), renders the success of the Osage less than could be desired. A contractor had planted several miles of hedge directly from seed, giving as the reason that the tap root should never be cut.—(*Trans. Nebr. St Hort. Soc.*, 1877, pp. 70, 82.)

Franklin County.—From a statement published in 1877 (*Trans. of Nebr. State Hort. Soc.*, p. 46) it appears that in Franklin County 100,000 black walnut trees had been put out, and most of them one year from the nut; 150 box-elder trees; 500,000 cottonwood trees, and an equal number of cuttings. The trees were doing well, but the cuttings (which ordinarily thrive as well as young trees), were mostly dead, or rather were dead when set. The hedge-planting of the county had been of cottonwood, the young trees being set about 18 inches apart, for a live fence.

Furnas County.—Artificial groves are being planted to considerable extent; the species in favor being ash, box-elder, walnut, and cottonwood.—(*Trans. Nebr. St. Hort. Soc.*, 1877, p. 84.)

Hall County.—The original forest of this county was nearly all destroyed when the Union Pacific Railroad was built. Cottonwood, white ash, and elm were all cut down for ties and fuel, and the best timber now is in artificial groves scattered all over

the county on different farms. The oldest of this is fifteen or sixteen years old;—cottonwood and black locust. The former is now 65 to 70 feet high, and the latter 25 to 35. More recently white ash, white elm, black walnut, box-elder, soft maple, silver maple, honey-locust, European and American larch, and a few other kinds have been planted, and when properly tilled are in good growing condition. Probably 500 acres of these groves have been planted. From 20 acres of my own planting, and now mostly sixteen years old, I have had plenty of fuel for the last six years, besides considerable material for fencing and building. The wild forests are gradually growing up again, but frequent fires too often destroy the young growth of trees.—(*Wm. Stolley,* Grand Island, Hall County, Nebr.)

In a more recent paper, Mr. Stolley says:

In 1870 I noticed the workings of a borer, and only the black-walnut trees have entirely escaped. If applied in time, and when the sap is ascending the tree in spring, sulphur is effective in driving out the borer. As near the ground as possible I bore two-inch holes opposite each other, and put in two spoonfuls of sulphur, and then plug the holes tightly. Of course this is a slow process, and can scarcely be applied except to choice trees, and before they have suffered much. Where the trees have grown 6 by 6 the borers have done more harm than where they have grown 8 by 8, and if allowed to form a good top they have not been attacked. The little borer is found in the forks of the limbs, but have not done much harm; the birds assisting in their destruction.—(*Trans. Nebr. St. Hort. Soc.*, 1877, p. 85.)

Two hundred rods of hedge, of gray or white willow, were set in Hall County in 1873, and since then it has been set out extensively for hedges, and with success. There are many hedges also of honey-locust and Osage orange, the experience being in favor of the former and against the latter. The locust succeeds wherever protected during the first winter after setting out; still the native black willow is believed to be the best hedge-plant, and both this and the white willow are thought to be as good and efficient hedges as can be made.—(*Ib.*, p. 71.)

JEFFERSON COUNTY.—Sufficient interest is not shown in forest-growing, but the interest is increasing. The favorite kinds are ash, soft maple, box-elder, and walnut. Cottonwood is not a favorite, though planted on account of its rapid growth. The Osage orange has not succeeded as a hedge-plant, but the gray willow cannot be spoken of too highly for groves, windbreaks, and hedges, being hardy, of quick growth, and ornamental withal.—(*Trans. Nebr., St. Hort. Soc.*, pp. 69, 81.)

NEMAHA COUNTY.—In April, 1868, I obtained from the bluffs on Mission Creek, near the Otoe Indian reservation, about 700 young red cedar trees, mostly 2 to 3 inches high, some 6 to 8. I planted them 4 inches apart, in rows a foot apart, keeping them covered with fresh-cut grass. At least 95 per cent. lived, and in two years 420 were transplanted, 6 feet apart in a single row, being then from 6 to 12 inches high. They are now (1877) 7 to 12 feet high, two-thirds as wide as high, and well branched from the ground. Those well manured are much larger and finer in every way than those that were not.—(Mr. Aldrich, in *Trans. Nebr. St. Hort. Soc.*, 1877, p. 78.)

OTOE COUNTY.—A writer in the Nebraska Farmer (May, 1877) says:

Twenty years ago cordwood sold in Nebraska City for $7 or $8, and sometimes $10 a cord, and that, too, at a time when her population was not one-fifth what it is now; and, notwithstanding the demand for fuel is at least ten times greater now than in 1857, it is a fact that good merchantable wood can be bought in our streets for from $3.50 to $5 per cord. The reason of this is simply from the fact that the natural groves have been protected from fire, and the artificial groves are turning out an abundance of good wood, such as the necessities of the country demand for fuel. It will agreeably surprise any one not acquainted with the fact to know the amount of timber one acre of land will produce in the course of ten years. Mr. Richard Justice, who came here in 1857, and planted about ten acres of cottonwood in 1859, has one or two outhouses built from hewed logs taken from that grove, and the family have all the fuel they need. Hundreds of such cases might be mentioned throughout the eastern portion of the State, did space permit.

In an historical address delivered at Nebraska City, Nebr., July 4, 1877, by the Hon. J. Sterling Morton, the importance of tree-planting was strongly urged, and the citizens of Otoe County were invited to sign a pledge agreeing to plant on the 16th of November following the number of trees set opposite their names. About forty persons engaged to plant numbers ranging generally from 25 to 1,000, and in all something over 7,400. Most on the list left the kind to be planted indefinite, although the box-elder, black walnut, maple, red elm, ash, and cottonwood were named as having preference with others.

The average rainfall here is about 29 inches; prevailing winds in summer south and southwest; in winter, north and northwest. Among the indigenous trees most planted, are the coffee-bean, box-elder, soft maple, honey-locust, and cottonwood, besides gray ash, black walnut, and mulberry. The chestnut, birch, Scotch pine, Austrian pine, and the Menzies spruce from the Rocky Mountains all thrive when properly planted out and mulched for the first season. Our soil forces forest-growth with wonderful vigor, and wherever prairie-fires are kept out the timber-groves are swiftly incroaching upon the plains.

The European larch does not succeed, the soil being too dry and porous for it. The yellow locust *was* cultivated here, but it was so infested with borers that it has been abandoned generally. No other trees in this vicinity are suffering from insect enemies, so far as I know.

The best method of planting forest-trees is in rows, north and south, 8 feet apart. Alternating the rows with hard and soft wood trees is an advantage in securing a better growth for the hard wood. To illustrate: Plant first a row of cottonwoods, then one of black walnuts, and then one of cottonwoods. The latter grow swiftly and run up above the intermediate walnuts. Then the latter, struggling for light, shape themselves into tall and symmetrical trees, whereas planted on the open prairie alone they become stubbed and gnarled shrubs. The quickly-growing varieties planted in this way, with hard wood and slowly-growing varieties, act as nurses, and bring them up properly. I have tried this. Tree-planting is a mania in Nebraska, and hundreds of thousands of trees are planted every year on *Arbor Day*.[1]

The climate has changed very perceptibly during the twenty-two years that I have lived in Nebraska and on this farm. Our annual rain-fall has increased more than one-third. * * * Personally, I have the satisfaction, though now only forty-five years of age, of having grown here, upon the high, loamy prairie, saw-logs of cottonwood which will measure 6 feet in circumference at the but and 4 at the limbs 20 feet from the ground; black walnuts from the seed which will measure 3 to 4 feet in circumference, and apple-trees nineteen years old, blooming full every year and measuring in girth from 39 to 46 inches all through the orchard which I planted.—(*J. Sterling Morton, Nebraska City, Neb.*)

PAWNEE COUNTY has about 500 acres of thrifty artificial groves, besides wind-breaks and groves of less than one acre. Cottonwood and soft maple predominate, with some ash, walnut, elm, and honey-locust. The latter has been used to some extent as a hedge, but it does not meet with much favor. The ash, which is a native timber-tree, makes good growth and is free from vermin.—(*Trans. Neb. St. Hort. Soc.*, 1877, p. 80.)

About 400 miles of Osage hedge is planted in Pawnee County, much of which is a good fence, though neglect in some cases has made it a failure. About four years are found necessary to rear such a hedge that will defy stock, and at a less expense than posts alone could be furnished. To fence a quarter section on the boundary-lines (2 miles), 4 acres must be plowed twice, at a cost of $1.50 per acre = $12; 140,000 plants, costing $21; planting, at 50 cents per M, $7; total, $40, or a little over 6 cents a rod. The after-culture is but little more than that required, in good husbandry, for corn, except pruning, which is less than the labor of clearing a corn crop. Mr. Barnard, in reporting these facts, gives the following advice as to planting: "In the first place, the hedge-row should never be broken so as to leave the back furrows where the hedge is to be planted. On the contrary, a land not less than 1 rod wide, should be laid off, making a dead furrow to be set, and the second plowing should be done in the same way, deepening the dead furrow. Then back-set into that dead furrow, and you have a deep-tilled bed (and not ridged) wherein to set the plants; cultivate as level as possible, and never allow ridges along the hedge-row, and the better cultivated and wider the hedge-row, the less danger from gophers. In the after-cultivation, keep the ground loose and clean, but never cultivate with the plow after the middle of July, as this will promote too late a growth, and when winter comes the wood may not be ripe. The reasons for not ridging are threefold. The wind does not blow off the dirt, nor the rain wash the soil from the roots, and the frost does not throw the plants to the ground. The plants were set behind a spade, and 8 inches apart, 8,000 to the mile."—(*Trans. Neb. St. Hort. Soc.*, 1877, p. 67, 72.)

RICHARDSON COUNTY.—Our county is the best timbered of any in the State, although mostly prairie, with timber only along the streams, and especially on the bluffs of the Missouri River. The growth consists of oak, cottonwood, elm, walnut, and some ash and maple. About one-twentieth of the area is timbered, and this part is worth from $10 to $50 per acre. Many of our farmers have planted cottonwood groves, which have proved a success, and of much benefit as windbreaks.—(*Wm. Pachen*, Williamsville, Richardson County, Nebraska.)

During the last four years a large amount of Osage hedge has been set in Richardson County, and it answers every expectation.—(*Trans. Neb. St. Hort. Soc.*, 1877, p. 68.)

---

[1] The writer claims great advantages from this custom of devoting one day to tree planting, of which he is the inventor and founder, and with the results of which he is quite satisfied.

SALINE COUNTY.—Both Osage and honey-locust succeed as hedges. With the same amount of trimming the former makes the thickest fence, but the latter does not require so much protection. For wind-breaks, box-elder and willow are used, though cottonwood is most common. The willow makes a good wind-break, but not a good hedge.—(*Trans. Neb. St. Hort. Soc.*, 1877, p. 74.)

SAUNDERS COUNTY.—The majority of our farmers have groves covering from 1 to 15 acres each. We shall not reach the profit-maximum of tree-planting until 10 per cent. of every farm is devoted to thrifty-growing forest-trees. The trees mostly planted are cottonwood, maple, walnut, ash, elm, box-elder, and Lombardy poplar, and, among the evergreens, cedar, Scotch pine, Norway spruce, &c.—(*Trans. Neb. St. Hort. Soc.*, 1877, p. 80.)

This county has had many failures in Osage hedges, yet a number of good ones have been started—showing that with proper care it will succeed. Some farmers are trying honey-locust, which seems to do well, and others, the box-elder, which is hardy, and will bear crowding, which produces a stiff brush that will support wires when 5 years old.—(*Transac. Neb. St. Hort. Soc.*, 1877, p. 69.)

The indigenous trees most cultivated in this county are cottonwood, box-elder, red maple, white ash, black walnut, red cedar, basswood, and red mulberry. The elms, oaks, and hickories have not as yet been tried to much extent. The red-bud is planted for ornament. Of trees not native of this part the Scottish, Austrian, and white pines, larch, butternut, silver-leaved maple, spruces, firs, and gray willows thrive, but the pines, spruces, and firs do not appear to grow as well as in sandy and granitic soils. Trees thrive best on a north slope. The chestnut generally fails, whether started from seed or transplanted, unless shaded for a few years. The heat appears to scald it, as also the tender varieties of fruit-trees. The Osage orange and Lombardy poplar frequently winter kill, as does the French willow. The sugar-maple has been tried, but with indifferent success. The silver-maple and balm of Gilead, when once rooted, can scarcely be exterminated. The black locust grows rapidly, but is sure to be wholly destroyed by the borer, which also works on the soft maple, killing perhaps 15 per cent., and a little upon the cottonwood, and upon all sun-scalded fruit-trees. From 1856 to 1870 the tent caterpillar was a great pest upon the wild plum, but has now mainly disappeared. The curculio and codling moth are now most troublesome to fruit. Blight affects the pear and tender apple-trees. The best remedies against the curculio are shaking off by concussion, and insectivorous birds; with the codling moth, birds, and a paper-band fastened around the trunk of the tree.

Cottonwood does well when planted 4 feet apart each way; box-elder and red maple, 2 feet; black and white walnut, 1 by 4 feet, and white ash the same. But a better way is to alternate maples, walnuts and ash, with cottonwood, giving them the benefit of shade of the latter, until the third year, and then thin out annually. This practice prevents low branching, to which these trees have a tendency. To prevent sun-scald our fruit-trees must be headed low and leaned to the southwest so that the trunk may be shaded. According to the assessor's returns of 1876, the planting of this county was 2,651,537 forest trees, and 62,953 fruit-trees. Add to this the planting of 1876, there must be now at least 3,000,000 planted forest trees.

It is the prevailing opinion among early settlers in Nebraska, that the breaking of the prairie, and the planting of trees have increased the rain-fall, and a residence of twenty-three years in the State has impressed me thoroughly with the belief that such is the fact. Springs now exist where water was not formerly found, and crops do not suffer from droughts as in early days. The rank-growing blue-stem grass is constantly traveling westward, and crowding out the dwarfish buffalo-grass. We think that the good effects of planting are already felt in an increase of moisture, and the multiplication of insectivorous birds, and as a consequence the decrease of noxious insects. Young timber comes up, when fires are kept out, and trees of the same kinds, when large trees are cut.—(*Moses Stocking*, Wahoo, Saunders County, Nebraska.)

SEWARD COUNTY.—Osage hedge can be raised here as well as in Iowa. Many farmers, however, are trying locust, which is said to be doing well. In raising a hedge, the chief enemy to be overcome is the gopher.—(*Trans. Neb. St. Hort. Soc.*, 1877, p. 69.)

WASHINGTON COUNTY.—The European White Willow is highly esteemed as a hedge and wind-break. It grows rapidly, is easily cultivated, and is valuable for fuel and poles. Cottonwood, box-elder, soft maple, and ash are being planted as groves.—(*Trans. Neb. St. Hort. Soc.*, 1877, pp. 72, 87.)

YORK COUNTY.—There are numerous fine groves in all parts of the county, which have been set one to five years, mostly of cottonwood. There are from 250 to 300 acres planted in timber besides wind-breaks on boundary-lines, &c. The law exempting from taxation has been a great assistance. In 1876 there were $21,675 exempted on account of timber and orchard planting. Hedges in York County have not proved very successful, there being not more than five miles. The failures are attributed to poor plants, poorer setting, and still poorer culture.—(*Trans. Neb. St. Hort. Soc.*, 1877, p. 70, 82.)

DAKOTA TERRITORY.

This region, in its general characteristics, resembles the adjoining parts of Minnesota and Nebraska, being naturally a treeless country except along the rivers and streams. The hilly and broken region of the western part is thinly timbered in the valleys.

SULLY COUNTY.—*Fort Sully.*—This post is about 2,000 feet above sea level, and 200 above the Missouri River, being on the *second bench*; a third one about 100 feet higher being of the general level of the country, which is gently rolling, and cut with beds or streams of water, or the dry channels of the same. The soil is alkaline throughout this entire region. This is what was formerly regarded as the "dry belt," but there appears to have been a change in the rain-fall. In 1873 it was 14.62 inches; in 1874, 16.24; in 1875, 14; and in 1876 (less April), 17.26; in the first seven months of 1877, 17.17 inches.[1] The summer climate is quite warm, 98° in the shade having been noticed almost daily for two months in 1874, and on one occassion, 112°. But since that year the weather has not been so hot, and there has been now and then a cool day in summer, and always cool mornings and evenings. The buffalo-grass now retains its green longer, and grows longer, than was noticed three years ago.

The only trees in the country are on river-bottoms, and in narrow strips along the creeks and ravines. The cottonwood is the only timber-tree. Red cedar is found of considerable size, generally in the ravines, where the dwarf-plum is also plentiful. Wild grapes, and a wild fruit called Buffalo or bull berry are also found. The willow, kinnikinic, wild rose, and sweet briar are also abundant on the bottoms, and the hackberry, wild cherry, and white and scrub oaks are also occasionally found.

In 1875 about 80 trees were planted by Maj. H. M. Lazelle, First Infantry, around the sides of the parade-ground (but at some distance from the buildings), and about 30 or 40 more around the officers' quarters and laundresses' quarters. These trees were watered regularly. Those near the officers' quarters have all lived, and done almost as well as if left on the river-bottoms, while those around the parade-ground, with the exception of about half a dozen, died, and were replaced by others in the spring of 1876. These latter appear to have a struggle for existence, and about 15 have recently died. I think it a fair conclusion that the partial shading from the sun has something to do with the better growth of those near the quarters. It is noticed that while for the first two or three years the growth of those entirely without shade was almost imperceptible, at the end of that period they appeared to take a sudden start and grew rapidly.

The climate of this post is exceedingly cold in winter (sometimes — 40°). It occasionally thaws, and in case there should be several inches of snow on the ground it disappears without being followed by mud or even wet. It appears to evaporate rather than melt.

The Missouri River is constantly changing its bed from side to side of its narrow valley. As it cuts away the bank on one side, it shoals on the other, until, in the course of time, the bottom reaches high-water mark, when a dense growth of willows commences. At the lowest stage of the river sand-bars appear in great numbers occupying the greater part of the bed of the stream. When these become dry, the wind raises clouds of dust, which further elevates the newly made land, and the willows are in time replaced by a growth of cottonwoods.—(*Thomas Sharp, 1st Lieut., First Infantry, United States Army.*)

NEW MEXICO TERRITORY.

Professor Hayden, in his report of 1871 (p. 223), says:

New Mexico presents a very large treeless area. Around the sources of the Pecos, along the eastern and southern rim of San Luis Valley, on the Mimbres and Guadalupe Mountains, and in the northwestern part of the Territory are found the principal forests affording valuable timber, while the rest of its area is generally without forests or trees of any value except for fuel. Fortunately the forests are generally in the vicinity of the narrow agricultural areas, and in some instances the trees are large and fine, making good lumber; but most of the older towns and villages have to procure their lumber and fuel at a considerable distance.

DONA AÑA COUNTY.—The valley of the Rio Grande, running through this county, where not cultivated, is covered with a growth of cottonwood, making very fair fire-

[1] It is since learned that 1869, 1870, and 1871 were wet years. It is quite probable that the amount varies considerably in different years, and until a long series of records have accumulated, we cannot with confidence conclude that there is any permanent change.

wood. The logs are used for joists, on which the earth used for roofing is placed. The foot-hills, immediately adjoining the river-bottoms, are covered with mesquite timber, a kind of shrub with enormous clusters of roots, which are dug out and used as fuel. They make an intense heat, and are almost equal to coal. They also make excellent charcoal for forge use. On the mountains, in various parts of the county, are small quantities of pine, oak, juniper, cedar, ash, hackberry, walnut, and mulberry, generally scrubby, and the pine alone of sufficient size for sawing into lumber. It makes very fair lumber for finishing. The ash is of good quality for wagon-making. A considerable amount of this timber lies along the bed of the Rio Grande, brought down by the current. It grows rapidly, and is really a valuable timber, being tough and strong. It is being cultivated to a limited extent. Within the last four years the Osage orange has been introduced for hedges and is found to grow thriftily. This and the ash, if set out along public roads and boundary lines, would, in a few years, supply a great want in furnishing wood for various uses. The Eucalyptus is also being introduced, as well as the Monterey cypress, but the result is not yet determined.—(*T. Casad*, Mesilla, Dona Aña County, New Mexico.)

SANTA FÉ COUNTY.—In most of the cañons and gorges of New Mexico, timber large and excellent, principally pine, is found in great quantity. The report of the 35th parallel railroad route through New Mexico refers to the supply of timber to be found along the proposed railway line. From the most reliable data within reach we estimate that in New Mexico there are 5,000,000 acres of timber land, including all lands not destitute of trees. The principal trees found in the mountain valleys of New Mexico are the ash, walnut, and hackberry, and on the mountains pine, oak, cedar, piñoreal, and piñon. The principal tree of the deep valleys and stream-margins is the cottonwood, a brash tree, which will not make lumber, but it is a beautiful shade tree, found transplanted around residences, and which answers most of the requirements for building and fencing.—(*T. M. Senay Baia*, Santa Fé, N. Mex., quoting from Brevoort's *New Mexico, Her Natural Resources and Attractions*, 1874.)

COLORADO.

The waste of timber by the early miners and settlers in Colorado was extremely reckless and improvident. Mr. Raymond, in h s second report of Statistics of Mines and Mining (1870), in speaking from his own observation and statements furnished by Mr. Wm. N. Byers, of Denver, says:

When the Territory was settled, some ten years ago, the mountain-sides were found covered with thick forests of pine, spruce, fir, and other trees, most of them of small size and short body. A given space would not give a large quantity of lumber or wood, as compared with many timbered countries, but for that reason it was more valuable, and economy of more importance, because there was no other source of supply. Generally these forests were green and flourishing. Only at rare intervals could a tract be found that had been burned over by the Indians and the trees killed. To-day, certainly one-third, possibly one-half, in all the settled portions of the Territory are dead—killed by fire. And outside the settlements, in regions visited at long intervals only by prospectors, their tracks can be everywhere seen in blackened trunks and lifeless, desolate-looking hill-sides. During the dry, scorching latter summer, the eye seldom glances over the mountain landscape without seeing somewhere—often in several places—the dense column of smoke that indicates a burning forest. Some of this destruction is fairly attributable to accident, more of it to culpable carelessness, and yet more to criminal design.

Another source of timber waste is in the felling of trees unnecessarily. Often a man, finding a good body of timber for lumber, will go to work and slash down hundreds or thousands of trees, thinking that some other man will come in with a saw-mill and buy his logs. Sometimes the customer makes his appearance, but often he does not until the logs are rendered nearly or entirely worthless by decay and the ravages by worms. But even if the saw-mill comes, there is no effort at economy. Timber is plenty; it belongs to the United States, and the pioneer has as good a right to it as any one else. Hence only the best is used. The tree that would furnish three saw-logs and the top two cords of wood, if it belonged to the logger or mill man, in this case supplies but two logs, and the remainder is left to rot or to be devoured by the fire that is set when the neighborhood has been skinned of its most valuable trees. The saw-mill is pulled up and moved a mile, or five, or ten, to another fine grove, where the same thing is done over again, and so on. At Central City, the oldest and most populous gold-mining center of Colorado, the consumption of wood for fuel is very large. A few years ago it was purchased for $2 per cord, but the increased distance of hauling has advanced the price about one dollar each year, until now it frequently costs $10. Lumber has to be brought from 20 to 40 miles, and heavy mill timbers often much farther. And, to obtain these articles, they are robbing and skinning districts that may at any day require their own timber, just as much as Central City

ever did. Denver, which formerly obtained her supplies of lumber within twenty or thirty miles, now has to haul much of it sixty. Other examples might be cited, but it would only be an accumulation of evidence.

Professor Hayden, in speaking of the resources of Wyoming Territory, in his report of 1871 (p. 224), says:[1]

The principal timbered sections of Wyoming are those along the southern boundary of the Territory and in the extreme northwestern corner; large tracts of country, even within the mountain districts, as Laramie Plains, the Green River Plains, and Sweetwater country being almost entirely timberless.

Mr. Henry Gannett, in reporting to Professor Hayden the geography of a division between parallels of latitude 38° 45′ and 39° 30′, and between the 8th guide-meridian of the land-survey on the east, and by the 107th meridian on the west, makes the following statements concerning the timber:

The plains forming the eastern part has no timber, except on the summit of the divide. The Colorado or Front Range, a plateau region rising abruptly from the plains, is sparsely timbered with pine and spruce. Between Tarryall Creek and the South Platte, the country is open, park-like, and well watered, as also is most of the country lying south of the South Platte. There is plenty of the best timber and grass. There is no timber in South Park except on the sides, but in the mountains there is an abundance of the best timber. West of the Park Range is the valley of the headwaters of the Arkansas River, 5 to 10 miles wide, well watered, and sparsely timbered. Eagle River heads opposite the head of the Arkansas, in Tennessee Pass, and flows northwest to the Grand River. There is an abundance of timber in the hills. The vegetation of the mountain valleys, drained by the Gunnison River and Roaring Fork, have a rich soil, derived from limestone and sandstone, with pine and spruce trees covering the ridges heavily, while the bottoms are choked by quaking aspen trees.

Mr. Gannett, in his botanical notes, mentions as among the trees affording timber, the *Populus balsamifera* var. *candicans*, the cottonwood occurring at middle elevation, and the only poplar that could be used as timber; *Pinus ponderosa*, the yellow pine, growing 70 to 100 feet high, and common on the lower slopes, a most useful timber tree; *Pinus flexilis*, on the divide between South Park and the Arkansas Valley; *Pinus edulis*, the piñon pine, near Colorado Springs and Twin Lakes, and *Abies Engelmanni*, the white pine, growing 60 to 100 feet high, wood closely allied to the black spruce of the east, and found on the mountain slopes of the Elk and Sawatch ranges.

The timber line was found as follows:

	Feet.
Pike's Peak, east face	11,721
Mount Guyot, north face	11,811
Mount Silverheels, northeast face	11,549
Mount Lincoln, east face	12,051
At head of Buckskin Gulch, south face	11,587
Station 52, Park Range, east face	11,663
Station 56, Park Range, east face	11,752
Park range, Mosquito Trail, west face	11,656
Park range, Mosquito Trail, east face	11,656
Station 40, near Mount Evans, south face	11,559
Buffalo Peak, northwest face	12,041
Sawatch Range, head of Frying-pan Creek, west face	11,583
Massive Mountain, north face	11,607
Mount Elbert, east face	11,871
La Plata, east face	12,080
Grizzly Peak, south face	11,758
Mount Harvard, east face	12,117
Station 89, near Mount Princeton	11,514
Station 63, Elk Mountains, east face	11,513
White Rock Mountains, south face	11,919
Station 68, Elk Mountains	11,686
Station 82 on ridge north of Frying-pan Creek	11,830
Station 75, near head of Texas Creek	11,574
Mean elevation of timber line	11,694

[1] Report, 1873, p. 671.

Mr. S. B. Ladd, in reporting to Professor Hayden[1] upon the topography of the Middle Park division, embraced between latitude 39° 30′ and 40° 20′, and between longitude 104° 45′ and the Park range, which forms the western boundary of the Middle Park, mentions—

The ridges and mountains as well timbered, mostly with yellow and white pine (*Pinus ponderosa* and *Abies Engelmanni*), and the parks and valleys as bearing a fine growth of scattered timber. In the vicinity of the mining towns a great deal of timber had been cut, and in places over large districts it had been destroyed by fire. An area of 1,200 square miles was timber-bearing, and the remainder either above timber-line, or else taken up in the open valleys and parks. The western division, including the Middle Park, drained by the Grand River and its tributaries, was well timbered on the spurs thrown out from the main range, especially in the eastern half of this section. The hills formed by the metamorphic rock grew timber, mostly white pine, although on the western slopes it is smaller than on the eastern. The amount of this granite timber area is about 675 square miles. The lignite areas, which comprise a large portion of the park, are essentially timbered, but the quality is very inferior to that growing on the metamorphic rocks, and the southern slopes are generally bare. Over large areas the timber has fallen, making it often difficult to travel away from the trails. This class of timber land might be estimated at 425 square miles. The regions covered by the lake-beds are, as a rule, totally destitute of timber. The areas covered by Cretacious No. 1 bear timber, while the remainder of this formation, occupying the lower valleys and partially covered by the lake-beds, does not represent a timber country. This is illustrated in the valley of the Blue, where the timber growth follows the outcrop of Cretacious No. 1 across the valley. This class covers about 150 square miles of country. The hills capped with lava, grow timber. All told, there are about 1,250 square miles of timber land in this western subdivision.

The timber-line is reported within the boundary of this exploration as follows:

	Aspect.	Approximate latitude.	Elevation.		Aspect.	Approximate latitude.	Elevation.
		Deg. Min.	Feet.			Deg. Min.	Feet.
Mount Evans	E.	39 35	11,300	Bald Mountain	E.	40 00	11,100
Gray's Peak	N.	39 40	11,100	Long's Peak	E.	40 15	11,100
Mount Powell	N.	39 45	[2]11,600	Mount Lillie	....	40 15	11,100
Mount Byers	S.	39 50	11,400	Station LX	S.	40 20	[2]11,600
James's Peak	E.	39 50	11,100	Park View	E.	40 20	[2]11,100
Arapahoe Peak	S.	40 00	11,100				

Some very successful examples of evergreen planting may be seen in Denver and its suburbs. The plants are taken from the mountains, being carefully lifted by spades, and laid upon coarse canvas, which is then bound firmly around the ball, and the trees are taken to the place where they are to grow. The auspicious time for this operation is just after the new growth has started, and while the functions of life are most active. This at Denver occurs about the early part of June. The plant should be abundantly watered as the roots are adapting themselves to their new conditions.

The lumber business of Denver in recent years has been as follows:

1872.	Planing-mill products	$115,000	Lumber trade	$950,000
1873.	Planing-mill products	256,000	Lumber trade	809,000
1875.	Planing-mill products	305,000	Sash, doors, and blinds	275,000
	General lumber business	320,000		
1876.	Lumber, sash, and doors	578,000	Wood manufactures	95,000

Arapahoe County.—The trees commonly cultivated about Denver are the cottonwood (3 varieties) and box-elder that are native, and silver maple, white ash, elm, and honey and black locusts that are introduced. The mountain ash and sugar-maple fail. The willow and cottonwoods come in of themselves in some places, without irrigation, where stock is kept out.—(*Wilson Perrin*, Denver, Colo.)

[1] *Geological and Geographical Survey of Colorado*, 1873, p. 661.

[2] Estimated.

WYOMING TERRITORY.

In the report upon the reconnaissance of Northwestern Wyoming and the Yellowstone National Park, in 1873, by Capt. William A. Jones, U. S. A., it is estimated that the timber of this region covers 2,000,000 acres,[1] the presence of which indicates a somewhat equitable amount of rain-fall, doubtless sufficient for cultivation without irrigation, so far as its great elevation and summer frosts may admit.

Hilliards, near the southwestern corner of this Territory, and on the line of the Union Pacific Railroad, is a point of some importance in the production of wood for charcoal and railroad ties. It is brought in a V-shaped flume about twenty-eight miles from the United Mountain region, where the supplies, although difficult of access, are said to be somewhat abundant. This flume will carry logs 30 inches in diameter and 20 feet long, and will deliver 150 to 200 cords in twelve hours.

Albany County.—The Laramie Plains are some 7,000 feet above sea-level, about 100 miles long and 30 broad, with the Black Hills of Wyoming to the east and the Medicine Bow range to the west. Rain-fall, 17.97 inches in 1872; 13.14 in 1873; 10.86 in 1874; 11.97 in 1875; and 10.97 in 1876. The soil is good, but liable to frost in every month, unless, perhaps, July. The native trees in the mountain gorges are pine, and on the water-courses cottonwoods and aspens. A few trees at Fort Saunders, planted along a ditch (aspens and cottonwoods), are apparently healthy, but they would probably die if the water was cut off. About half a million of pine ties are used annually in replacing ties along the Union Pacific Railroad.—(*A. G. Brackett*, Fort Saunders, Wyo.)

MONTANA TERRITORY.

In an article[2] upon the sylva of Montana, Dr. J. G. Cooper enumerates the following species as growing within the Territory:

Rhus glabra (Smooth Sumac). No species found above Fort Union, and one found on the Columbia plain north of Fort Colville may be distinct.

Negundo aceroides (Box-Elder). Reaches Fort Benton but does not pass the mountains.

Acer glabrum (Smooth Maple). From east base of Rocky Mountains to the Cascade Range, becoming 40 feet high and a foot in diameter.

Cerasus Virginiana? (Choke Cherry). Across the mountains to the Bitter Root Range, growing 20 feet high and 6 inches in diameter.

Cerasus mollis? A shrub at Cœur d'Alêne Mission and westward taken to be this. It had a stunted growth.

Pyrus fraxinifolia vel *Americana?* (Western Mountain Ash). First appear on east slope of Cœur d'Alêne Range, scarcely a tree.

Cratægus rivularis (River Hawthorn). From east base of Rocky Mountains to Cascade Range, growing 15 to 20 feet high. Finest along the Spokan River.

Cratægus sanguinea? (Red Hawthorn). Sparingly from Walla Walla to Fort Colville.

Frangula Purshiana (Oregon Bearwood). Both slopes of Cœur d'Alêne Mountains, but not farther east. A bushy *Rhamesus* is found with it.

Amelanchier alnifolia (Oregon Service-Berry). From east base of Rocky Mountains to Pacific coast.

Cornus pubescens (Green Dogwood). Seen near crossing of Bitter Root River, and at intervals to the coast.

Celtis reticulata (Western Sugar-Berry). Strictly limited toward northwest by Snake and Columbia Rivers, as observed in 1853.

Quercus Garryana (Oregon Oak). Not east of east base of Cascade Range, or north of Yakima River. No oak occurs from the Columbia River to Fort Union, on the Missouri, where the *Q. macrocarpa* (Burr Oak) occurs. No ash grows to a similar interval, though one extends to Milk River on the Missouri.

Fraxinus Oregona (Oregon Ash). First appears at the Dalles.

Betula occidentalis (Western Pogue-Birch). A shrubby tree from Sun River through the Rocky Mountains to Cœur d'Alêne Range, where it becomes of large size, 60 feet high and 2 in diameter.

Alnus viridis? (Green Alder). Perhaps a new species, or *A. rubra*. Range similar to western birch, and of greater size to the west.

---

[1] Report, p. 58.

[2] *American Naturalist*, October, 1869. The article cited contains many notes upon botanical characters, &c., which are here necessarily omitted.

Salix (Willow). Several species not determined.

Populus angustifolia (Narrow-Leaf Poplar). Not east of base of Rocky Mountain, at Fort Benton and Fort Laramie.

Populus balsamifera (Balsam-Poplar). The prevailing species of "cottonwood" on Missouri River, above Fort Union and across Rocky Mountains; not uncommon to the west coast.

Populus tremuloides (Aspen). At intervals throughout the mountains, usually about gravelly ponds, but not common.

Pinus contorta (Twisted Pine). Most prevalent tree of higher Rocky Mountains, as far on the west slope as Deer Lodge Prairie. Beyond Bitter Root it again becomes abundant. Its growth seems more dependent on a certain degree of moisture rather than temperature.

Pinus rigida (Pitch-Pine). Common on east spurs of Rocky Mountains, in upper "Bad Lands" of the Missouri, from Milk to Judith River, and on Black Hills near Fort Laramie.

Pinus ponderosa (Yellow Pine). Prevailing species in most parts of Rocky Mountains traversed.

Pinus monticola (Western White Pine). Scattered trees on highest part of Rocky Mountains; from east base of Cœur d'Alêne Range to summit it is abundant, but disappears farther west.

Abies Menzesii (Black Spruce). Abundant on higher part of Cœur d'Alêne, as on the coast.

Abies grandis and *amabilis* (Oregon Yellow Fir). Perhaps the same species. From east slope Cœur d'Alêne Mountains westward.

Abies Douglasii (Red Fir). About same distribution as *Pinus ponderosa.*

Abies Williamsoni (Williamson's Spruce). Abundant *only* on summits of Cœur d'Alêne Mountains, where it grows 3 feet in diameter and 100 feet high.

Abies Mertensiana (Merten's Spruce). On slope of Cœur d'Alêne Mountains, but not on summit.

Larix occidentalis (Western Larch). Bitter Root Valley, and common to Fort Colville.

Thuja gigantea (Western Arbor Vitæ). Fully developed on western slope of Cœur d'Alêne Range; trees range from 6 to 8 feet in diameter, and very close together.

Juniperus Virginiana (Red Cedar). Large and abundant along the Upper Missouri, and more scattered across Rocky Mountains.

Taxus brevifolia (Oregon Yew). From eastern slope of Cœur d'Alêne Mountains westward to Lake Cœur d'Alêne.

In speaking of the supplies of timber for the mining interests of Montana, Mr. Raymond in his Report of 1870, p. 259, says:

Fortunately, Montana is much better timbered than the Territories farther south, although the forests are chiefly confined to the mountain ranges. Pine, fir, and spruce abound in the mountains and cañons, and small growths of balsams, alders, willows, and aspens are found in the valleys in the neighborhood of larger streams. In the immediate vicinage of active mining operations the supply is rapidly diminishing, and transportation from a greater distance is necessary; but the otherwise inexhaustible supply is more seriously threatened by the extensive forest fires. During the past dry summer (1869) these have been particularly disastrous, blackening an immense belt of country. The most charitable explanation of their origin ascribes them to carelessness or natural phenomena, as it is difficult to conceive the degree of wantonness and villainy necessary to undertake the intentional destruction of magnificent forests.

ARIZONA TERRITORY.

The mining enterprises of this territory have proved very destructive, and have exhausted the supplies of one place after another, until wood and timber are now procured only from considerable distances and at large and rapidly increasing cost. The difficulty and cost of procuring water by irrigation will probably prevent anything being done with success, excepting in the more favored localities, and as a general rule there can be no timber grown without this aid.

NEVADA.

An article on the resources of California, published in the summer of 1876, states that the mines on the Comstock Lode in Nevada use from 40,000,000 to 50,000,000 feet of timber per annum, involving the clear-

ing of about 3,500 acres of forest land yearly and a constantly increasing expense for logging, as the limit of supply was being rapidly approached. In addition to this demand for timber, the mines near Virginia City annually consume (according to the *Territorial Enterprise*) 40,000 cords of fire-wood, at an average price of $16 per cord. Lumber for mining purposes sold readily at Virginia City for $20 to $25 per thousand, embracing timber squaring 12 inches.

A correspondent in Elko County gives the following account of the forest resources of that portion of the State:

This region is in the great plateau between the Wahsatch and Sierra Nevada Mountains, and the locality reported from at the base of the Humboldt Range, latitude 41° 20′, longitude, 115° W.; elevation, 6,500 feet. This part of the State is about equally divided between mountain and valley. Rain-fall about 14 inches a year. The Humboldt Range rises 3,000 to 5,000 feet above the nearest arable lands, and its ravines and gorges are filled with groves of timber, the lower portion with quaking asp and balm of gilead, and the middle with groves of pine. The upper part of the mountain is covered with perpetual snow. The timber grows only in parts that are sheltered, the spaces between being covered with stunted quaking-asp and laurel, dwindling away and lost in utter barrenness toward the summit. The space between the laurel and the valley is covered with wild sage and wormwood, except the small groves of quaking asp that follow the movntain streams to the meadows, where they give way to the willow and osier that follow their course until it is dried up. On a lime-mountain, forty miles distant but in sight, there was a large grove of fir or spruce, covering, perhaps, ten square miles, but it has mostly disappeared. That mountain is 11,600 feet high; has a growth of mountain mahogany [*Cercocarpus*], giving it the appearance of a grove of gnarled apple-trees or burr-oak. Fifty miles south of here it is found all up the sides of the mountain, furnishing there the principal supply of fuel. The range east of the Humboldt Range is covered on its upper surface with piñon pine, and its lower part with juniper. The former supplies all the country hereabout, and the towns along the railroad, with fuel, and it is nearly all the timber in the eastern portion of Nevada. It is rapidly disappearing under the demands of the neighboring towns.

What our condition was for timber before this modern "upstart" Sierra Nevada raised his head between us and the clouds, is open to speculation. It is possible that under the *débris* in these valleys may be found beds of lignite or coal, that will supply the farmers and miners with fuel in the future. Well, we will trust it to the forestry commission and the subsidence of the Sierras.

There have been no experiments in forest-planting. Various seeds planted came to nothing. We have nothing for fencing, and fuel is getting scarce. We have no shade-trees around our dwellings. Nothing has resulted from government or State bounties for tree-planting. I have never noticed fungous parasites in the country. I have found galls upon the rose willow, sage, choke-cherry, and a wild unnamed shrub. We have a borer that destroys the piñon when kept in a dry place, and traces of insect-work are found under the bark of the quaking asp. An attempt to cultivate the large willow by covering cuttings with a plow, but it failed. The great need of this country is *some tree that will plant and tend itself*—something hardy—that will stand heavy winds and a cold as low as —10°. We have found nothing so far. As hardy a plant as the apple has failed under the shelter of a willow grove and a stone wall.—(*Mrs. E. R. Chase*, Wells, Elko County, Nevada.)

UTAH.

When the region now embraced within the Territory of Utah was first explored for settlement, about thirty years since, a large portion was an arid desert, and for the most part it was destitute of trees, excepting a scanty growth of cottonwood here and there along the streams, and a heavier growth of evergreens with few deciduous species in the cañons of the mountains.[1]

With scarcely an exception, it was necessary to provide irrigation before cultivation could be undertaken, and over extensive areas agricultural improvement can only be maintained through this means.

In 1867, 100,000 acres were irrigated, and $248,000 expended on canals and dams during the fiscal year ending October, 1867.

[1] The largest timber known to have been produced in the cañons of the Wahsatch Mountains hewed 70 feet long, and squared 8 inches at the smaller end. It grew in the Big Cottonwood Cañon.

According to statements made by A. M. Musser, before the Trans-Missouri Navigation Convention at Denver in October, 1873, there had been constructed in Utah, up to the year 1865, over 277 canals and ditches for irrigation having a total length of 1,043½ miles, and costing $1,766,939, or an average of $1,695 per mile. The estimated cost of works in progress was $877,730.

In 1872, returns from 25 main canals were received, showing the following results: Total length, 165 miles, varying from 1½ to 27 miles; width of bottom, 3 to 18 feet, average 6½ feet; depth, 4 inches to 3 feet, average 15½ inches; fall in a mile, 2½ inches to 75 feet, average 23⅞ feet; acres watered, 40,750, average to each canal, 1,638 acres.

He stated that when Salt Lake City was first founded, the water-capacity for irrigation did not exceed 800 or 900 acres; now between 4,000 and 5,000 acres are irrigated. The soil after becoming saturated and settled in the early years appeared to require less water, and it was found that after successive years of watering the upper or bench lands, the arable lands below needed no irrigation as the percolation from above was sufficient. As a general rule, the county courts regulate and control the waters in the main canals by the appointment of a head water-master, with subordinates.

The following statistics from the *Report of the Deseret Agricultural and Manufacturing Society* for 1875, contain the latest information that we have upon this subject in Utah:

Length of trunk irrigation canals (miles)	2,095¼
Cost of the same	$1,918,174 84
Length of distributing canals (miles)	4,888¾
Cost of the same	$503,320 00
Total cost of irrigation canals, including cost of repairs for 1875	$2,527,678 84
Annual cost of repairs	$106,184 00
Number of acres requiring no irrigation	77,525
Acres requiring from 1 to 2 hours of water per week	35,706
Acres requiring from 3 to 4 hours	87,774
Acres requiring from 4 to 10 hours	21,761
Acres reclaimed from salt and alkali lands	6,157
Acres reclaimed from swamp lands	3,490
Acres planted with nut trees	5½
Acres planted with shade trees	871

It is stated with much confidence that the necessity for artificial supply of water is every year becoming sensibly less, and that 77,525 acres are now reported as requiring no irrigation.[1] Popular belief is united in the opinion that the extremes of temperature are now less than formerly, the summer rains more frequent, and the climate more humid. They can now raise corn and other crops which could not formerly be done, on account of summer frosts, which do not occur now as in the early days of settlement.

With respect to the timber supplies of Salt Lake City, reliance was entirely had upon the cañons, and notably that of the Big Cottonwood, which opens into the valley from the east, about thirteen miles southeast of the city. It was first explored in 1853, and a road made under great difficulties, and, it is said, at a cost of $25,000. The most valuable timber which it supplies is the "red pine,"[2] "white pine,"[3] balsam fir, and

[1] In a visit to Salt Lake City in June, 1877, we were informed by President, Brigham Young (since deceased), that during the present season, people in the valley were able for the first time to grow wheat without irrigation in places where it had formerly been quite impossible.

[2] Understood to be the *Pinus contorta.* Its wood has a reddish hue, and it is very strong and elastic. It is from this timber that the frame of the convex roof of the "Tabernacle" is constructed.

[3] *Abies Engelmanii* (?).

quaking asp. The latter is chiefly used for charcoal and fuel. The timber in this cañon, which is said to fairly represent that of the mountains of this region generally, occurs most towards the upper part, in coves and lateral valleys, and much more abundantly on the northern slopes.

From the deep snows that fall in these elevated regions, no lumbering can be done in winter; the streams although abundant in flow are of no use for transportation, and operations are now restricted to three or four months in the summer season. There are at present some seven or eight mills driven by water and one by steam in the Big Cottonwood Cañon. The machinery is of cheap and rude construction, with circular saws and overshot wheels. The production is from 2,000,000 to 3,000,000 feet a year. As the timber is cut off, the upper valleys are more exposed to sweeping winds, which carry the snows over the crests, where hanging masses form, until they fall, and, gaining force as they slide, sweep everything before them till they reach bottom of the valleys. Several acres of the asp and of small evergreens may be seen in several places that have been prostrated by these snow-slides, and their increasing frequency renders the reproduction of timber impossible. This is believed to fairly represent the timber of the cañons of this region generally. It is extremely difficult of access, quite limited in amount, and apparently without chances for renewal.[1]

The lumber markets of Salt Lake City and of Ogden are partly supplied with lumber brought from the Michigan and Wisconsin pineries, and from the lumber mills of the Coast Range and the Sierras, more particularly those of Truckee, near the eastern border of California. The redwood and the sugar pine of the Pacific Coast thus meet the white pine and the black walnut of the East in these middle markets of the continent. The fact that lumber is brought these distances by railroad, is a sufficient indication of its superiority in quality over the native woods of this region, or a sign of failure in their supply.

The mining operations of the Wahsatch and other ranges have created a new and extensive demand for timber and especially fuel.

The consumption of charcoal in the smelting-furnaces of the Territory is becoming every year a question of practical importance, and the difficulty of procuring it an increasing item of expense.

According to the statistics, published by the Deseret Agricultural and Manufacturing Society, for 1875, the amount of charcoal made in the Territory during the year was 8,674 tons, valued at $132,837.50. It is chiefly used in the silver smelting-furnaces of the valley, and the timber mostly used for this purpose is the quaking ash. This timber grows at the upper levels in the valleys, and well up to the timber-line.

The capacity of irrigated land for timber-growth is fully illustrated by the experiments already tried, and the latest returns show that about 880 acres have been planted in the Territory. This amount is altogether insignificant as compared with probable wants, and is not sufficient to

[1] Since the opening of numerous silver mines in the Great and Little cottonwood cañons, or rather on the dividing ridge that separates them, the timber has found a local demand which is hastening its destruction. In a recent visit to this country, an instance of reckless destruction came under notice, which cannot be regarded as unusual in the mining region of the West. The supply having failed in the Little Cottonwood, an adventurer had come over the snow-clad divide into the basin at the head waters of the Great Cottonwood, and cut down a million feet or more of valuable pine, as a speculation, but failing to realize from sales, it was left to rot on the ground. The rings of growth on one of the stumps thus cut, showed the age of the tree to have been over four hundred years, which may be regarded as about the usual period required for timber to grow to its greatest dimensions in these high altitudes.

account for the increasing volume of water in the Great Salt Lake in recent years.[1]

The trees first planted for shade and ornament in the streets of Salt Lake City were the native narrow-leaf cottonwood, which in late years have been attacked and to a large extent destroyed by a borer. A few of the broad-leaf species were planted, and these have suffered in like manner. In recent plantings, the cottonwoods have been altogether neglected, and many avenues of this tree are being replaced by other kinds, the black locust having preference, as regards number planted, although the honey-locust thrives extremely well, makes a finer-shaped tree, and produces a timber of better quality. The white and black mulberry, white and red elm, balm of gilead, ailanthus, and catalpa are found to thrive, and the box-elder grows with great luxuriance. The soft maples, and the sugar-maple grow but slowly, and for this reason are not regarded with favor. Most of the fruit-trees of the temperate zone are cultivated by aid of irrigation with great success.[2]

The reader is referred to an address by Prof. Paul Chadbourne (now president of William's College), before the Massachusetts Board of Agriculture (Report for 1871, p. 61), for many interesting details concerning irrigation, &c., in Utah.

Instances are mentioned of settlements being commenced in Southern Utah where the supply of water appeared scarcely sufficient for more than three or four families, but as the soil came to be cultivated the supply increased, so that now from fifty to a hundred families find support. These instances the leaders of the Mormon church claim of the fulfillment of prophecy, and an evidence of Divine favor. As *facts*, they can only be explained by attributing these changes to the conditions brought about by cultivation and planting. The amount of tree culture is not sufficient to account for any notable difference in climate, and the meteorological records of the Territory are too few and for too short a period to show any definite laws of climate. The average rain-fall at Camp Douglas, 3 miles east of Salt Lake City, from a series of records kept 10 years, is 18.87 inches. The months in the order of greatest rain-fall are: May, 3.02; December, 2.58; January and March, each 2.21; February, 1.38; April, 1.96; October, 1.22; November, 1.15; July, 0.85; September, 0.77; August, 1.70, and June, 0.62 inches.

The timber-line in the Uinta Mountains is 11,000 feet above tide; below this these mountains are covered with a dense forest very much interspersed with small openings of meadow.[3]

---

[1]The facts relating to this increase, its causes, and the periods of its fluctuation, if such exist, belong to other departments of investigation. It is sufficient here to notice, that there can be no denial that the waters of the lake are now less salt than when settlement began, and some 12 feet deeper than in 1861.

[2] It is to be regretted that we have not sufficient instrumental records to show the foundation for the popular belief that the climate of Utah is now more moist and the temperature more uniform than it was thirty years ago. It is thought that showers are more frequent in summer than formerly, and corn is now raised in places where it was once liable to be killed by late spring frosts. The dews are now more abundant, and there is manifestly greater humidity in the climate than when this region was a desert.

The borders of the valley clearly mark the levels of the lake in ancient times as much above the present; and looking out, on a winter's morning, from the elevated site [of Camp Douglas], the valley is often seen filled with floating vapor to the highest level of the old lake-shore, and the valley with its thriving cities and settlements, and the bases of the surrounding mountains, are submerged, as it were, a thousand feet under water, forming a perfect image of the ancient scene.—(*Report on the Hygiene of the United States Army*. Circular No. 8, 1875, p. 338. Report of Surgeon E. P. Vollum.)

[3]Capt. W. A. Jones, United States engineer, in a *Report upon the Reconnaissance of Northwestern Wyoming*, p. 48.

CALIFORNIA.

This State, in common with the country further north, presents striking contrasts of abundance and destitution in regard to its timber supplies, suggesting active and efficient measures for conservation on the one hand, and patient and persevering efforts at restoration on the other. Nothing short of a discriminating and prudent policy on the part of the General and State Governments, in whatever comes within their province, and a thoughtful regard to future interests on the part of private owners of land, will save this region from the unpleasant consequences that would follow the entire exhaustion of the supplies of timber now available for commerce. In this question the consequences affect not only our own country, but also many others, who have been for years drawing upon these supplies as though they had no limit.

The worst feature of this question is, the thoughtless waste and total loss that has attended the management of these timbered lands, so far as owned by private persons, and the destruction that has happened in the want of management where the lands belonged to the Government. This waste by improvidence, plunder, and forest-fires, is more fully noticed elsewhere in this report.

Before noticing such details as we have been able to gather, we will present the observations of scientific observers as to the general character of the forests of this coast, and some official statements of the lumber production.

Dr. Asa Gray, in speaking of the contrast in vegetation between the Atlantic States and California, separated as they are by wide treeless plains and lofty mountains, says:[1]

> California has no Magnolia nor tulip-trees, nor star-anise tree; no so-called paupaw (*Asimina*); no barberry of the common single-leaved sort; no Podophyllum or other of the peculiar associated genera; no Nelumbo nor white water-lily; no prickly ash nor sumach; no loblolly-bay nor stuartia; no basswood nor linden-trees; neither locust, honey-locust, coffee-trees (*Gymnocladus*), nor yellow-wood (*Cladrastris*); nothing answering to Hydrangea or witch-hazel, to gum-trees (*Nyssa* and *Liquidambar*), Viburnum or Diervilla; it has few asters and golden-rods; no Lobelias, huckleberries, and hardly any blueberries; no Epigæa, charm of our earliest spring, tempering an icy April wind with a delicious wild fragrance; no Kalmia, nor Clethra, nor holly, nor persimmon; no Catalpa-tree nor trumpet-creeper (*Tecoma*); nothing answering to Sassafras, nor to Benzoin tree, nor to hickory; neither mulberry nor elm; no beech, true chestnut, hornbeam, nor ironwood, nor a proper birch-tree; and the enumeration might be continued very much further by naming herbaceous plants and others familiar only to botanists.
>
> In their place California is filled with plants of other types—trees, shrubs, and herbs, of which I will only remark that they are, with one or two exceptions, as different from the plants of the eastern Asiatic region as they are from those of Atlantic North America. Their near relatives, when they have any in other lands[2] are mostly southward on the Mexican plateau, or many as far South as Chili.

Observations of Prof. J. S. Newberry upon the forests of California and Oregon.

Professor Newberry estimates the number of species of forest-trees growing north of San Francisco and south of the Columbia as not exceeding fifty, distributed among the following genera: *Pinus*, 8; *Abies*, 5; *Picea*, 3; *Sequoia*, 2; *Cupressus*, 2; *Thuja*, 1; *Libocedrus*, 1; *Larix*, 1; *Taxus*, 1; *Torreya*, 1; *Quercus*, 5; *Populus*, 3; *Salix*, 5; *Fraxinus*, 2; *Acer*, 2; *Alnus*, 1; *Cornus*, 1; *Platanus*, 1; *Castanea*, 1; *Æsculus*, 1; *Arbutus*, 1; *Oreodaphne*, 1. The conifers largely exceed the dicoty-

---

[1] Address before the *Am. Asso. for Advancement of Science*, Dubuque meeting, 1872. p. 9.
[2] *Pacific Railroad Survey*, vol. vi, Botany, p. 11.

ledonous trees, both in size and numbers, and the heavy forests are mostly limited to the sea-coasts and mountain-sides, and he observes that different mountain-ranges are covered with vegetation that exhibits marked differences when compared one with another.

The areas between and eastward of the coast-ranges and Sierra Nevada have each a flora somewhat peculiar to themselves.

Coast Mountains, between San Francisco and the mouth of the Columbia.—These were covered, when observed by him in 1854–'55, with a continuous forest, denser toward the north. Immediately north of San Francisco they were almost exclusively of redwood (*Sequoia sempervirens*), which was limited to the valleys, especially such as opened toward the coast. Farther north the trees became more numerous, and the sugar and yellow pines (*P. Lambertiana* and *P. ponderosa*) were found. Near Crescent City these trees together formed a magnificent forest, the redwoods and sugar-pines growing to about equal dimensions, being not uncommonly 12 to 15 feet in diameter and 300 feet high.

Near the line of 42° a change was observed, growing if anything more dense, and the redwood disappearing and being succeeded by the Western white cedar (*Thuja gigantea*), Douglas and Menzies's spruces, which formed dense and almost impenetrable forests from Port Orford to the Columbia. The Douglas spruce here reached its greatest size, fully equaling the redwood and sugar-pine. In the valleys of the Umpqua and other rivers flowing into the ocean the *Quercus Garryana* grows alone or in groups, sometimes 2 to 3 feet in diameter, with a low, spreading top. In the transverse chains running back from the coast to Mount Pitt and Mount Shasta, the *Pinus Lambertiana, P. ponderosa, P. contorta, Picea grandis,* and perhaps *P. amabilis,* reached down nearly to the shore.

Sacramento Valley.—Excessive moisture in winter and spring, and summer droughts, characterize this region. The prevailing surface is prairie, with timber in narrow belts along the streams, varying in width and density according to the size of the streams and the extent of their influence upon the soil or air. Of trees growing in this region he mentioned the *Quercus agrifolia* and California white oak (*Q. Hindsii*), the nut-pine (*P. Sabiniana*), a tree highly characteristic of the flora of the interior, and generally distributed in the Coast Mountains back from the ocean. The manzanita (*Acrotostaphylos glauca*), *Platanus racemosa, Fraxinus Oregona, Populus monilifera,* and a few willows, alders, and vines make up the rest.

Sierra Nevada.—These mountains, with their continuation—the Cascade Range of Oregon—rising at many points high above the line of perpetual snows, give an alpine character to some of the vegetation, and, with the progressive changes downward, quite a variety of species. The Douglas spruce, the western balsam-fir, and some other trees which form a large part of the forests on the Columbia, extend at a higher elevation down to Mexico. The western slope, receiving rains from the Pacific, was clothed with a dense forest of conifers, including, with the exception of redwood, all those gigantic species that characterize the botany of western North America. On the west slope of the Sierra Nevada also occurs the *Sequoia gigantea*, or "mammoth tree." The greater part of the forests were made up of the yellow pine (*P. ponderosa*), sugar-pine (*P. Lambertiana*), western balsam-fir (*Picea grandis*), and incense-cedar (*Libocedrus decurrens*), which formed the greater part of this slope as far south as the latitude of San Francisco. The yew (*Taxus brevifolia*), and two species of cypress (*C. Nutkatensis* and *C. Lawsoniana*) were occasionally met with. Among the foot-hills, at a lower level, the nut-pine mingled with the oaks, reaching up to the pine forests above, but scarcely forming a part of them. The *Quercus fulvescens, Q. densiflora,* and *Q. Kelloggi* also occurred in the same zone, but not in considerable numbers.

Region east of the Sierra Nevada and Cascade Mountains.—There is here great uniformity in geological formation as well as in vegetable growth; the yellow pine (*P. ponderosa*) forming a continuous forest, a day's ride scarcely showing a dozen species of plants.

The Klamath Lakes, and along the Klamath River, in Oregon, where more rain falls, we have thickets of small trees, but the amount of timber is not large. The cottonwood and willows were found along water-courses, and yellow pine and western cedar on the hills. On the banks of the Klamath dense forests of the *Pinus contorta,* of small trees, were noticed.

Cascade Mountains.—These bear, besides the greater part of the species found on the Sierra Nevadas, some that do not extend into California. The western larch (*Larix occidentalis*) and the *Abies Williamsonii* are of this class.

Among the species mentioned in the local botany of this region, were the larch and several of the poplars (*Populus tremuloides, P. monilifera,* and *P. angustifolia*). A few hundred feet up the mountain-side the yellow pine, joined by the sugar-pine (*Pinus contorta*), western balsam-fir and Douglas spruce, together formed a thick forest. There were also seen some few trees of the *Thuja occidentalis* and large-leaf maple (*Acer macrophyllum*). A little higher was the *Pinus monticola* of Douglas, and

the silver fir (*Picea amabilis*). At 6,000 feet these gave place to the *Abies Williamsonii* and *Pinus cembroides*, which rise to perpetual snow. These species are observed on the Eastern slope. On the Western slope they appear mingled with others, the great mass of the forest being made up of the Douglas spruce, the balsam-fir, and western arbor vitæ. The Nootka cypress is confined to the western slope. These mountains, near the Columbia, are chiefly timbered with Douglas spruce and Western balsam-fir. The banks of the river are lined with cottonwoods, and in some places with Garrey's oak.

The lowest part of the Willamette Valley was occupied by the densest forest seen, composed chiefly of the Douglas spruce (here known as red fir), the western balsam-fir (here called white fir), hemlock, spruce, and arbor vitæ. Of diœcious trees, the large-leaf and vine maples (*A. macrophylum* and *A. circinata*) and the *Cornus Nuttallii* were the principal species.

Prof. J. D. Whitney, in connection with the geological survey of California, has given a general view of the distribution and character of the forest vegetation of the Sierra Nevada region.

In so elevated a range as the Sierra Nevada we should expect to find a number of belts of forest vegetation corresponding to the different zones of altitude above the sea-level. As in the Coast Ranges, the general character is given to the landscape by coniferous trees and oaks, all other families being usually quite subordinate in importance, and the number of the conifers as compared with that of the oaks increasing rapidly as we ascend.

There are four pretty well marked belts of forest vegetation on the west slope of the Sierra, and that of the eastern slope would make a fifth for the whole range. These belts, however, pass gradually into each other, and are not so defined that lines can be drawn separating or distinctly limiting them, and the division into groups or belts here proposed will only hold good in the central portion of the State. As we go north all the groups of species gradually descend in elevation, especially in approaching the coast.

Of the four belts on the western slope of the Sierra the lowest is that of the foot-hills, extending up to about 3,000 feet in elevation. Its most characteristic species are the digger-pine (*P. Sabiniana*) and the black oak (*Q. Sonomensis*). These stand sparsely scattered over the hill-sides or in graceful groups, nowhere forming what can be called a forest. The pale bluish tint of the pine leaves contrasts finely with the dark green of the oak foliage, and both pines and oaks are strongly relieved in summer against the amber and straw-colored ground. The small side valleys, gulches, or cañons, as they are called in California, according to their dimensions, are lined with flowering shrubs, of which the California "Buckeye" (*Æsculus Califorinca*) is, at this altitude, by far the most conspicuous, gradually giving place, as we ascend, to the various species of the delightfully fragrant *Ceanothus* or California lilac. Manzanita and chamiso are of course abundant everywhere, and especially on the dryest hill-sides and summits.

The next belt is that of the pitch-pine, or *Pinus ponderosa*, the sugar-pine (*P. Lambertiana*), the white or bastard cedar (*Libocedrus decurrens*), and the Douglas spruce (*Abies Douglasii*). This is peculiarly the forest-belt of the Sierra Nevada, or that in which the trees have their finest development. The pitch-pine replaces the digger-pine first, and more and more of the sugar-pine is seen from about the altitude at which the last-named noble and peculiarly Californian tree is most abundant. The sugar-pine is remarkable for the size of its cones, which hang in bunches of two or more from the ends of the large branches, like ornamental tassels. The timber of this tree is the best that California furnishes, and its size gigantic, being not unfrequently 300 feet in height, and from 7 to 10 feet in diameter. It is also in this belt that the "big trees" belong.

The third zone of forest vegetation is that of the firs (*Picea grandis* and *amabilis*) with the tamarack pine (*P. contorta*), taking to a considerable extent the place of the pitch and sugar pines. This belt extends from 7,000 to 9,000 feet above the sea in the central part of the State. The traveler to the Yosemite will see it well developed about Westfall's Meadows, and from thence to the edge of the valley. These firs, especially the *amabilis*, which is distinguished by the geometrical regularity with which its branches are divided, are most superb trees. They attain a large size, are very symmetrical in their growth, and have a dark green brilliant foliage, which is very fragrant. A pine called *Pinus Jeffreyi*, by some considered a variety of the *ponderosa*, is also a characteristic tree of the upper part of this belt, and above this sets in the *Pinus monticola*, which takes the place of the *Piceas* at a high elevation.

The highest belt of all is that of the *Pinus albicaulis*, or *flexilis* of some botanists, which marks the limit of vegetation in the Middle and Northern Sierra, *Pinus aristata* taking its place in the more southern region, about the head of King's and Kern Rivers. The *P. albicaulis* generally shows itself at the line just where vegetation is going to give out altogether, as around the base of Mount Clark, Mount Dana, and Mount Shasta.

On the last-named mountain it was seen growing as a shrub, in favorable places, up to 9,000 feet, and small trees were so compacted by the pressure of the snow on them in winter that a man could easily walk over the flat surface formed by their foliage. A little clump of this species just at the edge of the snow, on Lassen's Peak, shows the aspiring character of this tree, which is one widely distributed over the high mountain tops of the Cordilleras. The *P. aristata* is also found in the Rocky Mountains, as well as along a limited part of the highest region of the Sierra Nevada.[1]

Mr. C. H. Reed, president of the State Board of Agriculture, in 1868, estimated that a twentieth part of California was covered with heavy timber, and about an eighth, more or less, with trees of some kind. Within twenty years, at least a third of the whole native supply of accessible timber had been cut off or destroyed, and that, judging the future by the past, it would require about forty years to exhaust the entire present supply. This did not include estimates of the demands that might arise from increased population, or the extension of new industries, which might reduce the term to twenty years. One of the worst features in respect to this subject was the useless and criminal destruction of timber, which had been indulged in to an unprecedented extent. He says:

Thousands upon thousands of the noblest and most valuable of our forest-trees in the Sierra Nevada districts have been destroyed without scarcely an object or a purpose—certainly with no adequate benefit to the destroyer, or to any one else. This practice cannot be condemned in too severe terms; it cannot be punished with too severe penalties.

The hard-woods of California afford some noble specimens of ornamental woods; but for the strong and elastic kinds, used by carriage-makers, and for agricultural implements and the wood-work of machines where great toughness is required, the supplies come wholly from the Atlantic States. Mr. Reed, in 1868, says:

Even now the cost and scarcity of these articles are having an oppressive effect upon every industry in the State. The expense of agricultural implements and tools here over their cost in the Eastern States is already operating as a serious draw-back upon the thrift and profit of our farmers, brought in close competition, as they now are, with our neighbors of the Western Atlantic States. The cost of lumber for building and fencing, in most of our agricultural districts, obtained, as it is, at a distance of hundreds of miles away, is even now so great that our farmers are among the poorest housed people of any agricultural community in the Union, where the country has been settled an equal length of time. Their crops and stock are but poorly sheltered, if at all, and their farms are worse than poorly fenced. To the expense of lumber, more than any other cause, must be attributed the general dilapidated appearance of our agricultural districts.

This scarcity had led to forced systems of farming—too frequent cropping, too little nursing, and consequently too rapid exhaustion. Building improvements were checked, and the enhanced cost of lumber had raised the prices of rent. He concludes this statement with the question, which the future must answer: "If this be the case now, when we are so young, and our population so thin, when the demand for these articles is increased twenty-fold, and the supply decreased in the same ratio, who can depict the condition of our State?"

REDWOOD OF CALIFORNIA (*Sequoia sempervirens*).—This belongs to the same genus as the giant trees of Calaveras, Mariposa, and other points; is first in importance among the timber-trees of California. It sometimes occurs fifteen feet in diameter and three hundred feet high; and instances are mentioned of specimens twenty feet in diameter. It grows only on underlying metamorphic sandstone, and does not thrive in other formations. The redwood belt extends from Humboldt County, near the northern border, and reaches down the coast for a hundred

[1] *Yosemite Book.*

and fifty miles, terminating in Sonoma County. From Valhalla, the north boundary-line of Sonoma, to Russian River the country along the coast is timbered, and this timber extends inland about eight miles. The timber in the Russian River bottom is not surpassed on the coast. Fed by the rich alluvial soil and watered by annual overflows, the trees grow to an enormous size, some being 150 feet without a limb, and cases have occurred in which a single tree has been worked up into 65,000 feet of lumber, worth at least $1,000.[1]

The redwoods are not continuous, several interruptions occurring from change of geological formation from sandstone to lime-rock, or from the lowering of level. An instance of the former is seen at Tomales Bay; and of the latter from the lower foot-hills of Tamalpais down to Belmont. A connecting link is found, however, on the Oakland hills, and that grove of redwood, now almost destroyed, affords the strongest evidences of the dependency of this species on the prevalence of heavy mists. A few individual trees occur across the Oregon line, but none of commercial importance. A few small patches occur in Marion County, but these are fast passing away. It also occurs in Klamath and Del Norte Counties, in more or less disconnected patches. The redwood belt, at its best, is almost fifteen miles wide, but the average width is much less.

This is one of the very few of the conifers that sprouts from the stump when cut down. Fire is destructive to the young trees only, and after gaining a thickness of two or three feet, they are not liable to injury from this cause. The roots seem imperishable, and as soon as the tree is cut, they sprout and cover the soil rapidly, to the exclusion of every other species, none being of so rapid growth. The indestructibility of the roots prevents the clearing of such land, and even large trunks cut down, cover themselves, within two or three years, with sprouts so completely that they can scarcely be seen. The entire aftergrowth on the Oakland hills is owing solely to this growth from the roots and stumps. This tenacity of life shows itself also in the resistance it offers to fire. Trees that have been bereft completely of their branches by fire, will

---

[1] The wood in the tree standing is valued at the present time at $2 per M feet, a yield of 150,000 to the acre, or 6,000,000 on a forty-acre lot is an average on good lands. The very finest timber on the margin of the streams would produce at least 800,000 feet to the acre, and this yield runs down to 25,000 feet. As the redwood belongs to the foggy coast region, and as the supply south of San Francisco has been cut off, Sonoma, Humboldt, and Mendocino Counties may be said to have the monopoly of this timber while it lasts.

The yield of redwood lumber in 1876 was estimated at about 216,000,000 of feet.

The redwood is a close-grained timber, splits true, is very light in color, like the red cedar of the Eastern States. It works smoothly under the plane, and is not liable to warp or shrink. Its durability cannot be questioned, as hundreds of miles of fences twenty years old and still sound bear evidence. Hence it has been used largely for fence-posts and railroad-ties. Sonoma and Mendocino Counties furnish large quantities of ties to the Central Pacific Railroad. It is also used on the Southern Pacific, and is largely laid on the desert of the Colorado and in Peru. The late Henry Meigs, the projector of extensive railroad enterprises in South America, once owned a mill in Sonoma County, and appreciated the durable qualities of this timber.

The redwood varies in density, the heaviest being of a dark red color, and the lighter in weight being lightest in tint. Its average weight is 4½ pounds to the square foot. One instance was observed in which the timber sawed from a gulch weighed but 2½ pounds to the foot, while that from another, but a quarter of a mile off, parallel and leading into the same main cañon, was 6 pounds to the foot.

The trees growing on a gravelly soil are generally unsound on the top and in the heart, rotting from the top downward. When the tree stands on ground where the underlying rock is of a shelly or broken nature the timber is apt to be unsound. Upon precisely the same kind of soil, when the underlying strata are solid, the wood will be solid. The best timber is, of course, along alluvial river-bottoms, which rest upon a solid sandstone formation, though a good deal of hill-side timber when the rock is solid will make the best of lumber.—*Sonoma Democrat.*

cover themselves with young sprouts, like a dead trunk overgrown with ivy.[1]

A redwood forest is described as grand beyond power of appreciation to one who has not witnessed the dense masses of fog come rolling in from the Pacific, creeping through the foliage, covering the hill-tops, flowing down the opposite slopes, and filling the cañons until hill and valley are wrapped in dripping mist, or, as the process is reversed in early light of morning, as these fogs melt away and reveal the forests, in all their grandeur of dimensions and distance, stretching away until lost to view on the far-off horizon.

We may judge something of the requirements of the redwoods in any attempt at their naturalization elsewhere by noticing the climate in which they thrive. The seasons are alternately wet and dry. Rains begin in October and continue to occur till May, or rarely in June. It seldom rains more than three or four days at a time, and as soon as the rain-fall begins the herbage starts, so that by the middle of November the hills and pastures are green. December is a stormy month, with some snow and ice. January is a month of flowers and the seed-time of grains. Planting is done either in the fall or in January and February, or the first days of March. February is the growing month, like June in the Northern Atlantic States. March is a rude month, with southeast storms or dry north winds. April is a month of fluctuating weather, of rapid growth, and the rains being well nigh over, the moisture depends in part upon sea-fogs. Grain ripens in June, and is harvested in July. Fogs prevail from May to August, brought in the form of damp air by the trade-winds from the sea, and condensed by cooling on the mountains. When the trade-winds set in a fog-bank forms every day off the land, and in the afternoon it comes inland, spreading over the country through the rest of the day, and nearly through the night, thus repeating itself nearly every day through their season. The farmers estimate these heavy fogs as about equal to a light rain.[2]

---

[1] *Proceedings of California Academy of Natural Sciences*, iii, 232.

Dr. Gray, in an address before the American Association for the Advancement of Science, at Dubuque, in 1872, remarks as follows, concerning this timber:

"The forests of California, proud as the State may be of them, are already too scanty and insufficient for her uses. Two lines, such as may be drawn with one sweep of a brush over the map, would cover them all. The coast redwood, the most important tree in California, although a million times more numerous than its relative of the Sierra, is too good to live long. Such is the value for lumber, and its accessibility, that, judging the future by the past, it is not likely, in its primitive growth, to oulast its rarer fellow-species."

[2] R. A. Thompson's *History of Sonoma County, Calfornia* (1877), p. 20.

Dr. Henry N. Bolander, in a paper presented to the California Academy of Sciences, October 16, 1865 (*Proceedings* iii, 232), ascribes great importance to these fogs. In this article he says:

"Another great beneficial feature in this species (*Sequoia sempervirens*) is the great power it possesses in condensing fogs and mists. A heavy fog is always turned into rain, wetting the soil and supplying springs with water during the dry season. Springs in and near the redwoods are never in want of a good supply of water, and crops on the Coast Ranges are not liable to fail. The year of 1874 has proved my assertion beyond a doubt. This fact is generally known; a great deal of land has been taken up since. It is my firm conviction that if the redwoods are destroyed—and they necessarily will be if not protected by a wise action of our government—California will become a desert in the true sense of the word. In their safety depends the future welfare of the State. They are our safeguard. It remains to be seen whether we shall be benefited or not by the horrible experience such countries as Asia Minor, Greece, Spain, and France have made by having barbarously destroyed their woods and forests. But with us here it is even of a more serious nature. Wise governments would be able to replace them in those countries, but no power on earth can restore the woods of California when completely destroyed."

In the recently published history of Sonoma County the names of 14 establishments are given, of which 1 has a daily capacity of 35,000 feet of lumber; 9 of 30,000; 1 of 15,000; 2 of 12,000; and 1 of 10,000. Total, 354,000 feet a day, or 57,000,000 a season. Others are mentioned as preparing to operate, and extensions of narrow-gauge railroads were contemplated, which would largely increase the production. It also gives the following

Tabulated Statement of Timber Resources by Sections.

	Feet.
Between Valhalla and Russian River	437,000,000
Duncan's Mill Land and Lumber Company	216,000,000
Russian River Land and Lumber Company	450,000,000
Bodega country and north of Howard's Cañon	345,000,000
Opposite Guerneville	35,000,000
Hurlbut's Cañon, Big Bottom, Elliott's Cañon	350,000,000
Marshall timber on Mill Creek	15,000,000
	1,848,000,000

We have no means of verifying this estimate; but allowing a broad margin for error on the most favorable side, the period of exhaustion is not many years distant at best, and the subject should arrest the attention of capitalists in view of the large gain that may be realized in the future, by arresting thoughtless waste, introducing economical methods, and especially by carefully protecting the woodlands when once cut over, and allowing them the best possible conditions for reproduction.

THE "BIG TREES" OF CALIFORNIA (*Sequoia gigantea*).—These have attracted widely the public interest, rather on account of their enormous dimensions than their commercial importance. In fact, their very rarity led the General Government, a few years since, upon the memorial of a number of influential citizens of California and other sections of the country, to except the more important groves then known and the Yosemite Valley from sale, and to reserve them, under the care of the State of California, as places of public interest.[1]

---

[1] The "Cleft" or "Gorge," in the granite peak of the Sierra Nevada Mountains, at the headwaters of the Merced River, and known as the Yosemite Valley, estimated at fifteen miles in length, with an average width of one mile back from the main edge of the precipice on each side, was, by an act of Congress approved June 30, 1864, given to the State of California, upon condition of its being held for public use, resort, and recreation, and inalienable for all time. All incomes from leases or privileges were to be applied to preservation and improvement.

By the same act, the tracts embracing what is known as the "Mariposa Big-Tree Grove," not exceeding the area of four sections, and to be taken in legal subdivisions of one quarter section each, were also given to the State, with like conditions as to acceptance, inalienability, lease of privileges, and protection. Both these cessions were to be managed by commissioners, consisting of the governor and eight others, to be appointed by him, and to serve without pay.

This act was accepted by the State, in an act passed April 2, 1866, and commissioners confirmed. They might appoint a guardian with a salary of not over $500, and the State geologist was authorized to make a full survey and a statistical report. Penalties were imposed for injuries to timber, careless fires, &c., and a small appropriation was granted for expenses. The State has of late years allowed this trust to fall in arrears in its financial matters, by omitting to appropriate the means for paying the salary of its superintendent. It cannot, however, be supposed that it will permanently allow these irregularities to continue. The title of the Yosemite property has been a subject of litigation, and after a decision in the State courts in favor of the claimant, the title has been affirmed to the government by the Federal courts. The generic name of the "big trees," and of the redwood is derived from that of a Cherokee chief, whose English name was George Guess. He was the inventor of a system of syllabic writing which possessed such advantages and was learned with such facilities, that it speedily became a means of written communication among his people, and is still used by them.

The "big trees" have in recent years been found in large quantities, and both large and small in size in the Sierras at from 4,500 to 8,000 feet above sea level.

The best-known groves of the *Sequoia gigantea* are those of Calaveras, Tuolumne, Merced, and Mariposa. In Fresno County there have been found in recent years others, large and small, and the species is preserved to science in an abundance of young trees raised from seed in various parts of the world.[1]

The genial influence of snow in favoring tree growth is finely illustrated in the case of the "big trees" of California. The climate in summer is warm and dry, and it seldom rains, but the snows fall six feet or more in winter and lie on till May. From the absence of rains the soil is deep and the rocks are hidden by it. At the Calaveras Grove the ground appears to be much lower and more wet in summer than at Mariposa, and at the latter the trees are more widely spread on the slopes and high knobs of ground where the drainage is good.[2]

Height.	Circumference.	Height.	Circumference.	Height.	Circumference.
258	31	305	63	269	64
260	50	270	49	366	50
273	32	320	42	308	48
280	48	327	45	310	—
265	46	284	52	241	44
291	45	258	—	275	50
305	49	315	—	259	44
281	44	277	45	286	50

The circumference was measured above the swell of the roots, at about six feet from the ground. The diameter of the stump of the "original big tree" was 23 feet 1½ inches inside of the bark, which was two feet thick.—(*Proceedings of the California Academy of Natural Sciences*, iii, 204.)

A particular account of these trees will be found in the "*Yosemite Book*," published in connection with the Geological Survey of California, under the direction of Prof. J. D. Whitney, State geologist, and by authority of a State law.

EUCALYPTUS GLOBULUS.—*The Blue Gum of Australia.*—As much has been written concerning this species, and as efforts have been made with much success to introduce its cultivation in California, it may be proper to present some of the principal facts concerning it:

Our knowledge of this tree dates from 1792, when Labillardière, who was sent with the expedition in search of the unfortunate La Perouse, found it in Tasmania, and brought it to Europe.[3] But public attention was not called to it until its rediscovery,

---

[1] The giant sequoia was introduced into England in 1853, and it has been tried in that country and Scotland in a great variety of situations, to ascertain its preferences. It is found to do much the best in heavy clay land. It suffers from the easterly spring winds, but after a time recovers. It must have a damp climate, moist subsoil, prefers high grounds to low, and is sometimes injured by severe frosts. It is hardy at 860 feet above tide, where the Douglas spruce did not do as well. Taking into consideration its hardiness, rapid growth, large dimensions, and durability, it is thought to present qualities that render it proper for forest planting for future timber; but it must not have exposure to the east winds. The value of its wood has not yet been tested. An interruption of growth in midsummer, followed by a vigorous growth in the fall, has been noticed, probably causing confusion in the rings of wood, or perhaps a double ring in a year. It was introduced into France in 1854, and grows alike on plains, in valleys, and on hills, best on a northern or southern slope. It must have a sufficient depth of soil, and proves very difficult to transplant.—(*Les Conifères*, C. De Kirwan, ii, 66.)

This tendency to start again in autumn, due to the wet and dry seasons of its native locality, has very frequently proved fatal in the Atlantic States.

[2] The following are measurements of height and circumference of 25 trees in the Calaveras Grove, made by Dr. Charles T. Jackson and Joseph B. Meader, in 1865. The quantities are in feet:

[3] This naturalist, with rare sagacity, foresaw that this tree would become an important source of timber for ship-building. His journal, under date of May 12, 1792 (the expedition being then at the Bay of Tempests, Van Dieman's Land), says: "I have not yet been able to procure the flowers of a new species of Eucalyptus, remarkable for its fruit, which resembles a coat-button. This tree, which is one of the tallest in nature, since it measures upward of 160 feet, only blooms toward its upper extremity. The wood is suited to naval construction, and is durable, but neither so light nor so elastic as pine. Perhaps it would be advantageous, in making masts of it, to make them of many pieces, and to hollow the great trunks throughout their lengths, in order

so to speak, by M. Ramel, in 1854. Being then at Melbourne, Australia, his attention was attracted by the extraordinary vigor of growth of a young plant in the botanical garden of that city, and its graceful form and beautiful foliage. He brought its seed to Paris, and had no difficulty in making them grow vigorously in summer, but they were killed down by frost in winter. Although under glass they grew with the same vigor, and soon reached the utmost limit of their space, so as to bend over under the roof. Some plants, sown in 1861, when placed in the open air, in 1872, grew so rapidly that the idea was suggested of trying them in Algeria and the south of France. It was introduced in Corsica, in 1865, and a report made in March, 1870, states as the result of observation that they would prosper around the borders of the island, and to an elevation of about 400 feet above sea-level. Its power of absorption of moisture and its emanations tending to purify the atmosphere were commended, and its growth was rapid; trees but six years old measuring 59 inches at 20 inches above the earth.[1]

In the winter of 1870–'71, a large number of these trees, which had flourished ten years, were killed down by frost in the basin of the Rhone. Near Cannes a few resisted the cold. At Madrid, wood of three or four years' growth withstood the frost, and put forth shoots vigorously.[2]

A report from Nice, July, 1871, was not favorable. The tree was found to require a deep, fertile, and well-irrigated soil, without which it would perish in seasons of drought. A temperature of 40° to 43° Fahrenheit would seriously affect it, and it could not withstand the violent winds which blow in the winter months along the northern shore of the Mediterranean. The writer of this account expresses the opinion that it could not be raised in France to advantage, or at least not in thickets, with the design of extracting its essential oils.[3]

It was first introduced into Algeria in 1854, in the garden of Hamma, near Algiers, under the direction M. Hardy, and a writer in 1867 estimates that a hundred thousand plants had been distributed in different provinces, and its success equalled the highest expectations that had been formed concerning it.[4] M. Planchon, in speaking of its cultivation in that country (1874), says: "In Algeria it is most favorably naturalized. It triumphantly borders the railways, of which it has seen the birth and marked the date. The garden inclosure can no longer retain it. It is planted by hundreds of thousands, in groves, in avenues, in groups, in isolated places, in every section of the three provinces, and the foreigner who does not know the exotic origin of the Eucalyptus, would suppose it to be an indigenous tree."

This tree has been introduced in India, the Cape of Good Hope, Argentine Republic, Chili, Central America, California, and various West India Islands. The genus *Eucalyptus* embraces an immense number of species, about 140 being described by Bentham and Von Müller in their *Flora Australiensis*. They differ greatly in size, habit of growth, and qualities, and several of them possess valuable medicinal properties. The *E. globulus* grows in its native country to an immense size, rivaling the giant *Sequoias* of California.[5] The *E. amygdalina* has been seen 480 feet high.[6]

---

to give them more lightness, strengthening them by iron bands." The specific name was suggested by the fruit, which resembles an urn rather than a button. The form is that of a reversed cone, raising four prominent sides, slightly widened at the edge and hollowed in the center by four cells, which open by large radiating shoulders, separated by as many triangular tongues. Before flowering, this inferior part of the calyx, which becomes the fruit, bears a thick, wrinkled, conoidic cap, which some botanists believe to be the superior part of the calyx; others a corolla with consolidated stamens. It is from this covering that the plant receives the name of *Eucalyptus*, from two Greek words signifying "I conceal well," the cap for a long time concealing the stamens.—*Planchon's Eucalyptus globulus*, p. 9. Translated and published by the Department of Agriculture (1875).

[1] *Bulletin de la Soc. d'Acclimatation* [2], ix, 445.

[2] *Ib.* [2], viii, 148, 384.

[3] *Ib.* [2], viii, 387; see also *ib.* [2], ii, 672.

[4] *Revue des Eaux et Forêts*, vi, 16.

[5] In an expedition into the interior of the Australian continent by Walter Hill, a government botanist, the Eucalyptus was found at an elevation of 4,000 feet above sea-level, 159 feet in circumference at 3 feet from the ground, and 80 feet in girth at 56 feet. Shipbuilders procure timber in single pieces for keels 120 feet long, and for planking of vessels it is considered superior to American rock elm.

A bibliography of pamphlets and articles upon the *Eucalyptus* is given in the *Bulletin Mensuel de la Soc. d'Acclimatation* for January, 1877 (3d ser., iv, p. 59–63), and a list of species in the same journal for April, 1876. A large number of American publications upon this subject are omitted in the list cited.

[6] *Transactions and Proceedings of the Royal Soc. of Victoria*, Part I, vol. viii, p. 9.

It is particularly successful in the French colony of Reünion, where M. de Châteauvieux is occupied in the cultivation with marked success.

The superintendent of the botanical garden, Jamaica, reports (in 1877) that the blue gum, planted six years ago in the Cinchona plantations, were 60 feet high, with trunks a foot in diameter near the ground, and 6 inches at 20 feet. During the past year 3,000 plants were distributed, in addition to 2,000 the year before. Most of these were sent to the lowlands, where they do not succeed as well as those planted on the hills. He says:

The value of this plant on the hills consists in its importance as a timber tree, as it is not only one of the most durable and useful woods, but it grows with greater rapidity and to a larger size than any other known timber tree. Judging from the rate of growth attained by plants introduced six years ago, trees two feet in diameter are certainly producable in ten years from seed. It possesses another advantage, namely, the branches are not wide-spreading, like most other trees; hence, in forming a plantation, the plants may be set unusually thick.

The lowest altitude at which this tree should be planted within the tropics is probably 2,000 feet. The imports of timber in Jamaica amount to about 8,000,000 feet of timber and 5,000,000 of shingles.

The *Eucalyptus globulus*, and several other species of this genus, have been introduced into California with much success, and Prof. Robert E. C. Stearns, in a paper published in the proceedings of the California Academy of Sciences, July 1, 1872,[1] says:

An instance of rapid growth under my immediate observation is that of a specimen purchased by me of a nurseryman, which, at the time of planting (January 5, 1871), measured from the ground level to the extreme tip 6½ feet, and in about eleven months (December 8, 1871) had reached a height of a trifle over 15 feet. The diameter of the stalk when set out was half an inch, and at the final measurement 1¾ inches. I am prepared to hear of instances far exceeding my figures, but it should be borne in mind that we had very little rain after this tree was planted, and furthermore, that the locality was upon nearly the highest ground in Petaluma. This tree was occasionally, but only moderately, watered during part of the time. Other trees of this species planted at the same time also made a remarkable growth. Specimens raised by me from the seed, whose growth I have noted, show a gain of 10½ inches in 21 days, or half an inch per diem. The development of lateral branches is as suprising as its perpendicular growth. George C. Potter, esq., of Oakland, informs me that specimens upon his grounds nine years old, show a diameter of 12 inches.

The late Col. Ezekiel Jewett, in writing from Santa Baraba, Cal., September 13, 1876, says:

There are some thirty species of the Eucalyptus here, and their growth is marvelous. The blue gum seems to be the favorite, and there is one before me, three years and one month old, that is 20 inches in circumference 6 feet from the roots, and 32 feet high.

Professor Brewer cites from a local authority that a tree cut in 1874, in Sonoma, Cal., of 9 years' growth, which had attained the height of 96 feet, and a diameter of 18 inches at 4 feet from the ground.

Mr. Ellwood Cooper, of Santa Barbara, who has done much toward making known the value of this timber for cultivation,[2] in writing, November 28, 1876, says:

The only parts of California that have commenced the planting of Eucalyptus forests, so far as my knowledge extends, are Alameda County, Gen. J. T. Stratton, the principal, some 60 acres; in San Rafael there are probably 50 acres; in Los Angeles County, 100 acres; Santa Barbara County, 100 acres. In other parts of Alameda

---

[1] *On the Economic Value of certain Australian Forest Trees, and their Cultivation in California.*

[2] *Forest Culture and Eucalyptus Trees.* San Francisco, 1876. 12mo., pp. 204; and an other volume of the same title, pp. 621. The first of these contains a lecture by him, and two lectures and an article by Baron Ferdinand Von Müller, of Melbourne, Victoria. The larger volume embraces several lectures and articles by Baron Von Müller having an interesting application to the subject of Australian vegetation and its introduction into California.

County there are doubtless more groves, but I should judge not over 200 acres in all.[1] This is about the extent; but this industry has commenced, and very soon the whole interior will be dotted with forests of the Eucalyptus.

Attempts have been made to introduce the cultivation of various species of this tree in the Southern States, but without encouraging success. It has been found not hardy at Augusta, in Georgia. At Albany, in that State, hopes were entertained that it would be able to survive the winters, but an unusual frost in the winter of 1876–'77 killed it entirely, the temperâture having gone down to 14° F.[2]

At New Orleans it has been found too delicate, and, if successful on the Gulf coast, it would probably be in Florida or Southern Texas.

Although of wonderfully rapid growth under a genial climate, it is by no means certain that this timber would prove valuable for construction, or use in the arts, until ripened and hardened by time.[3]

Statistics of Lumber Manufacture in California in 1874, 1875, *and* 1876, *as reported by the Assessors.* (*From reports of Surveyor-General.*)

I.—Number of saw-mills.

Counties.[3]	Steam-power.			Water-power.			Counties.	Steam-power.			Water-power.		
	1874.	1875.	1876.	1874.	1875.	1876.		1874.	1875.	1876.	1874.	1875.	1876.
Alpine	1	1	....	2	....	....	Nevada	18	20	18	9	11	10
Amador	4	4	4	....	....	....	Placer	20	....	17	5	....	1
Butte	17	14	15	4	4	4	Plumas	2	5	4	4	8	5
Calaveras	4	3	1	1	2	2	San Bernardino	5	5	6	....	....	....
Colusa	2	2	2	....	....	....	San Diego	1	6	6	1	1	1
Del Norte	3	3	2	6	4	5	San Luis Obispo	1	1	1	....	1	....
El Dorado	8	11	11	3	3	3	San Mateo	12	14	12	....	....	....
Fresno	6	1	2	....	2	....	Santa Barbara	....	2	....	....	....	....
Humboldt	11	15	18	2	1	2	Santa Clara	3	2	1	2	1	....
Inyo	....	....	....	3	4	4	Santa Cruz	15	15	15	5	5	5
Kern	3	2	3	3	1	1	Shasta	1	2	4	11	10	10
Klamath	2	....	....	8	....	....	Sierra	11	11	10	9	8	8
Lake	7	6	6	2	1	....	Siskiyou	5	3	3	13	13	10
Lassen	2	....	4	3	....	1	Sonoma	14	8	15	....	....	....
Los Angeles	2	3	4	....	....	....	Tehama	7	7	8	2	3	1
Marin	1	1	4	....	....	....	Trinity	1	2	2	9	8	7
Mariposa	2	2	3	....	2	1	Tulare	3	3	5	2	2	1
Mendocino	14	17	18	4	3	3	Tuolumne	4	3	3	1	2	3
Modoc	1	2	1	6	7	8	Yuba	3	3	2	2	2	4
Mono	2	2	1	3	2	3							
Napa	....	1	1	....	....	....	Total	218	202	232	125	111	103

[3] Counties from which no returns were received are omitted from this table.

Sacramento County.—Two steam-mills, 1874; no product reported.

[1] A recent newspaper article states that the Southern Pacific Railroad Company are preparing to plant 200,000 Eucalyptus trees, in groves, at their several stations in Southern California.

[2] In an article in the First Annual Report of the Board of Health of Georgia, entitled "*Report of Committee on the Influence of Trees on Health*," by Dr. Benjamin M. Cromwell (1875), much confidence was expressed that this tree would grow and thrive in Southern Georgia, but this hope was disappointed by the casualty above noticed. The greatest difficulty had been supposed to occur in getting the plants through the first summer, until their roots penetrated well into the soil, so as to get a full supply of moisture, to resist the evaporation under a hot sun in dry weather. It was hoped that after the first year they would care for themselves, but experience proved that the danger lay in exceptionably cold winters rather than in dry and hot summers.

[3] Baron F. Von Müller, the eminent botanist of Australia, who has done so much toward making known the value of the blue gum, in a lecture delivered at Melbourne, June, 18[illegible]1, says: "That a period of a quarter or even half a century must elapse before a solid plank, hardened by age, can be obtained from even a rapid growing Eucalyptus tree. It is estimated to require twenty to twenty-five years before even a sleeper of blue-gum wood can be obtained from a tree planted in ordinary soil; and that double the time will elapse before a sown tree of the still more durable red-gum eucalyptus will furnish sleepers, such as hitherto have been in use for our railroad works. But a supply of fuel from these trees may be obtained much earlier. Mr. Adam Anderson, a timber merchant of this city, concurs in this estimate."

II. PRODUCTION IN SAWED LUMBER AND SHINGLES.

Counties.	Lumber sawed.			Shingles made.		
	1874.	1875.	1876.	1874.	1875.	1876.
	Feet.	*Feet.*	*Feet.*	*M.*	*M.*	*M.*
Alpine	1, 000, 000	200, 000	....	600, 000	10, 000	....
Amador	3, 800, 000	5, 000, 000	3, 950, 000	514, 000	1, 400, 000	450, 000
Butte	62, 000, 000	45, 000, 000	47, 000, 000	1, 700, 000	1, 500, 000	1, 200, 000
Calaveras	2, 960, 000	2, 000, 158	1, 000, 000	4, 000, 000	4, 003, 680	3, 000, 000
Colusa	2, 500, 000	300, 000	....	250, 000	100, 000	....
Del Norte	8, 125, 000	7, 000, 000	10, 000, 000	50, 000	10, 000	10, 000
El Dorado	1, 628, 500	6, 000, 000	4, 000, 000	....	....	....
Fresno	3, 600, 000	....	1, 500, 000	....	....	....
Humboldt	50, 000, 000	75, 000, 000	64, 000, 000	10, 000, 000	15, 000, 000	15, 000, 000
Inyo	982, 657	8, 628, 500	3, 828, 000	165, 000	1, 000, 000	800, 000
Kern	500, 000	4, 000, 000	....	100, 000	....	....
Klamath	2, 000, 000	....	....	1, 000, 000	....	....
Lake	3, 500, 000	3, 450, 000	3, 750, 000	400, 000	300, 000	200, 000
Lassen	3, 000, 000	....	2, 000, 000	95, 000	....	100, 000
Los Angeles	20, 000	30, 000	60, 000	....	....	....
Marin	600, 000	....	....	....	....	250, 000
Mariposa	1, 250, 000	....	1, 550, 000	100, 000	....	....
Mendocino	60, 000, 000	50, 000, 000	53, 000, 000	2, 500, 000	12, 000, 000	15, 000, 000
Modoc	3, 800, 000	2, 400, 000	3, 500, 000	....	150, 000	120, 000
Mono	10, 000, 000	1, 000, 000	250, 000	100, 000	100, 000	....
Napa	....	500, 000	700, 000	....	....	....
Nevada	50, 000, 000	6, 000, 000	30, 000, 000	25, 000, 000	200, 000	18, 000, 000
Placer	21, 670, 000	....	25, 550, 000	2, 619, 000	....	2, 500, 000
Plumas	800, 000	....	3, 000, 000	....	....	....
San Bernardino	2, 500, 000	3, 500, 000	3, 000, 000	220, 000	300, 000	200, 000
San Diego	500, 000	1, 975, 000	1, 875, 130	100, 000	75, 000	70, 000
San Luis Obispo	250, 000	200, 000	100, 000	....	....	....
San Mateo	6, 720, 650	6, 500, 000	5, 000, 000	32, 167, 520	41, 000, 000	37, 000, 000
Santa Clara	19, 137, 230	15, 197, 230	500, 000	....	1, 237, 000	....
Santa Cruz	27, 600, 000	20, 000, 000	15, 000, 000	9, 500, 000	1, 500, 000	10, 000, 000
Shasta	6, 000, 000	10, 450, 000	8, 100, 000	800, 000	675, 000	800, 000
Sierra	6, 500, 000	3, 500, 000	....	290, 000	200, 000	500, 000
Siskiyou	3, 500, 000	4, 000, 000	4, 000, 000	100, 000	150, 000	200, 000
Sonoma	49, 874, 350	40, 000, 000	60, 000, 000	2, 815, 000	10, 000, 000	10, 000, 000
Tehama	10, 000, 000	26, 914, 500	34, 450, 000	2, 000, 000	200, 000	....
Trinity	1, 400, 000	1, 800, 000	2, 000, 000	....	....	....
Tulare	6, 300, 000	7, 400, 000	93, 000, 000	500, 000	420, 000	22, 700
Tuolumne	5, 000, 000	6, 100, 000	5, 100, 000	1, 900, 000	200, 000	300, 000
Yuba	3, 000, 000	2, 000, 000	1, 500, 000	....	....	500, 000
Total	442, 018, 387	364, 044, 388	492, 263, 130	99, 585, 520	91, 730, 680	116, 222, 700

Receipts and exports of lumber at San Francisco in 1877.

A correspondent of the Northwestern Lumberman (February 9, 1878) gives the following amounts as received at that port in 1877, as compared with the two previous years:

Kinds.	1875.	1876.	1877.
Pine .... feet..	163, 395, 329	161, 338, 041	159, 742, 553
Spruce .... do...	12, 273, 570	16, 811, 299	9, 671, 448
Cedar .... do...	7, 730, 400	10, 474, 427	5, 940, 973
Hard wood .... do...	276, 759	50, 000	67, 000
Redwood .... do...	110, 309, 060	114, 128, 733	102, 626, 781
Pickets .... number..	1, 763, 117	1, 536, 656	2, 198, 473
Ties and poles .... do ..	4, 085, 666	285, 666	1, 409, 312
Sugar pine .... feet..	4, 000, 000	4, 535, 150	6, 865, 000
Total	303, 833, 901	309, 159, 972	288, 521, 540
Shingles .... M..	104, 931, 250	114, 305, 500	89, 468, 250
Laths .... M..	56, 006, 525	62, 313, 000	43, 443, 486

The exports by sea were reported as follows:

To what ports or countries.	1875.	1876.	1877.
	Feet.	*Feet.*	*Feet.*
Australia	1,022,211	1,411,534	1,470,871
Calcutta	664,470	....	115,000
Central America	527,641	275,482	593,271
Chili	300,000	769,211	1,770,545
China	1,136,813	148,036	604,505
Ecuador	....	....	16,000
England	110,659	250,000	17,764
Fiji Islands	137,000	81,000	....
Friendly Islands	151,647	....	....
Guam	....	....	55,460
Honolulu	745,668	1,511,338	1,428,000
Japan	20,000	....	20,019
Manilla	....	....	54,800
Marquesas Islands	43,300	168,885	81,233
Mexico	1,298,241	1,267,320	1,667,327
Navigator's Island	766,797	703,306	937,180
New York	5,000	....	57,713
New Zealand	7,000	14,057	285,897
Panama	287,689	113,594	177,822
Peru	1,378,775	2,445,652	3,084,752
Russian Asia	105,582	211,755	63,283
Tahiti	1,312,375	1,399,125	1,369,950
Victoria	3,321	7,925	2,875
Total	10,024,189	10,781,220	13,874,867

Alameda County.—The prevailing winds of this region are northwest. The rains vary greatly—from 7 to 20 inches in a year. The deciduous trees are the soft maple, California walnut, buckeye, cottonwood, willow, white oak, and sycamore. The conifers are cypress, of four species, redwood, Monterey pine, sugar pine, and *Picea amabilis* and *P. grandis;* of broad-leaved evergreens, are laurels of several kinds.

The Eucalyptus, of several species, does well in the valleys and on rocky hills—wherever the scrub oak grows—but will not endure the frost. The fig bears well, but the fruit is not so sweet as it is farther south. It requires a rich and rather moist soil. The orange, lemon, and lime ripen, and are perfectly hardy, their cultivation promising to develop into a large industry. They need water, and protection from chilling winds. The Eucalyptus forms the best wind-break. They are sold at about $6 per thousand, when one foot high. The coffee tree is under experiment, but it is too early to be certain as to the result.

The Japanese persimmon (*Diospyrus kaki*) is becoming a favorite, but has not yet fruited. The cork oak is growing well, but there is not yet much interest taken in it. The hemlock spruce, Norway spruce, and Austrian pine do not thrive, being stunted and miserable in the best soils, evidently from climate. The hickory and hard maple grow very slowly, and the pecan and beech much better. The locust grows, but not as well as in the Eastern States, and is apt to get diseased and to die young.

The woolly aphis is a continual trouble on our grafted apple-trees the second year, but on sandy soil less. Whale-oil soap has been found the best remedy. The stumps and refuse should be burned to get rid of the insects that harbor in them. The oak of this region is liable to attack from a borer. Among fruits, the cherry is most liable to injury by disease and insect ravages. Conifers can only be raised successfully by making seed-beds. They should be about four feet wide, sown in November, covering with sand, and protecting the next summer with laths. Deciduous tree seeds, apples, pears, &c., are sown in depressed beds in March, near a drain-furrow, mulching and watering by filling the beds (which are sunk two inches) with water from a hose when they need soaking. In this climate this treatment just suits them.—(*Chas. H. Shinn*, Niles, Alameda County, California.)

Mariposa County.—In this county occurs the *Yosemite Valley*, of wide notoriety. It comes within our province to notice only so much of this as relates to its forest vegetation, as mentioned in the "Yosemite Book," already quoted.

Along the banks of the river near the falls, there is a dense growth of alders (*Alnus viridis*), which sometimes forms quite a large tree, with ash-colored bark, associated with small trees of the *Rhamnus Menzieii*, remarkable for its large and somber leaves. A few willows, the Douglas spruce, and, in the upper part of the valley, an occasional sugar pine are also found in this position. Where the valley widens out, and the river banks become lower, so that sloughs and swamps are found, the balm-of-Gilead poplar (*Populus balsamifera*) comes in; this is a common tree in the valley, and is usually mistaken for the cottonwood. With this occurs large willows, an abundance of the Douglas spruce, and also the *Azalea occidentalis*, whose superb white and fragrant flowers form one of the charms of the valley.

The sandy region makes up the largest portion of the valley above Indian Cañon, has been evidently formed by the washing down of the finer portions of the *débris* from the walls, and is peculiarly the arboriferous belt of the valley. On the drier and looser portions the pitch or yellow pine (*P. ponderosa*) and the bastard cedar (*Libocedras decurrens*) are the most abundant and characteristic trees, both occurring of considerable size and fine proportions, the pines being usually from 125 to 150 feet high. Below the Bridal veil Fall, near the *débris*, the fir (*Picea grandis*), a noble tree, comes in; near the swampy land the black oak (*Q. Sonomensis*) is abundant. The sandy region also bears a great number and variety of shrubs and undergrowth; among these are the *Cornus Nuttallii*, with its showy white flowers, 3 inches in diameter; *Rubus Nutkanus*, the most beautiful of the raspberries, and found from Lake Superior west; also the characteristic California shrub, manzanita (*Arctostaphylus glauca*). The most characteristic tree of the *débris* piles is, perhaps, the mountain live oak (*Q. chrysolepis*, Lieb), which is associated in the higher portions with the common, shrubby, evergreen oak of the higher Sierras, perhaps the *Q. vaccinifolia* of Kellogg. In the vicinity of the points where small streams come over the precipices we find the Oregon maple (*Acer macrophyllum*), with its large and deeply-cut leaves, and, in the higher portions of the *débris*, another maple (*A. glaucum*), a shrub 10 to 15 feet high, whose delicate branches, long pedunculated leaves, and clusters of reddish seed, make it an object conspicuous for its beauty. Near the base of the *débris*, where the streams of the smaller waterfalls emerge, the California laurel (*Tetranthera Californica*) occurs as a small tree, with smooth, brilliant, evergreen foliage, and aromatic odor.

NEVADA COUNTY.—Wuckee, near the eastern border of this State, is the most important point for the manufacture of lumber and supply of mining timbers among the Sierras, and is one of the chief points for supplying Virginia City, Nev. There are in this vicinity several flumes for bringing timber down from the mountains, where it would be otherwise difficult of access. We have no statistics of the production of this region.

SAN DIEGO COUNTY.—A correspondent of the Ohio State Journal, writing September, 1875, from San Diego, Cal., says that within a radius of a mile of the court-house there were 4,759 shade and ornamental trees, not including fruit and nut trees; and that there were in the county 37,749 trees, all planted within six years. Among the kinds growing were the cork tree, date palm, India rubber, magnolia, Monterey cypress, Norfolk Island pine, Mexican pepper, and *Eucalyptus globulus*. The latter had grown 10 to 15 and even 20 feet in a single season. A tree planted from seed in January, 1870, measured 42 inches around at the base, and 32 inches at 6 feet from the ground. It was estimated as 60 feet high.

OREGON.

Prof. James D. Dana, in an article upon the physical geography of Oregon and Upper California,[1] before much settlement began, remarks that in the vicinity of the sea the country instead of being open prairie is covered with forests of evergreens:

In Oregon these prevail over the larger part of a breadth of 30 miles along the coast. In the vicinity of Astoria, as has been mentioned by various travelers, the trees of the dense woods are extremely large, 250 to 300 feet being a common height. In July, 1841, on an excursion to Mount Swalalahs, 25 miles south of Astoria, we traveled over a heavily timbered undulating country, passing trees occasionally 25 feet in circumference; and one measured was 37 feet. In some places the fallen trunks of trees (pines, hemlock, spruce, and alders) so obstructed the way that we were compelled to travel upon them, passing from one to another, seeing the ground 10 or 15 feet below us. The soil was generally good, and supported a thick growth of underbrush. There were flats near Chishuck's River, but they were covered with forests.

The country of the western section is thus divided longitudinally into a forest and prairie portion, the former densely wooded, the latter having only scattered oaks and lines of forest along the streams. Yet in these prairie districts, elevations over 1,000 feet high are wooded like the coast region, and the forests extend down their slopes, especially the northern and western, nearly or quite to their bases. Elk Mountain and the Umqua Ridges are thus densely covered with forests.[2]

Such was the primative aspect of the native forests of this State. We have given on a preceding page, in connection with our account of California, Professor Newberry's statement, from more particular examination made many years later.[1] The amount of foreign exportation will be presented fully in the statistical portion of the report. The coastwise trade is largely to the San Francisco market; but the amounts from this State cannot well be separated in these returns from those of Washington Territory.

A business article on the lumber trade of the Pacific Coast, published at San Francisco in July, 1877, states that the lumber shipped to that place from Puget Sound consists in the main of Oregon pine, with much spruce, rough and dressed, some cedar and some maple. The redwood comes from California ports. The ports then principally shipping to San Francisco were Crescent City, Coos Bay, the Columbia River, and along up the Coast to Victoria. The increase in the amount received at San Francisco had been as follows:

In 1874.—139,856,486 feet of Oregon pine, 11,866,163 feet of rough spruce, 765,690 feet of dressed spruce, 3,144,343 feet of rough cedar, 188,856 feet of maple, 1,019, 646 feed of redwood, 10,000,000 (nearly) of rough sugar-pine pickets, railroad-ties, telegraph-poles, &c.

In 1875.—163,695,426 feet of Oregon pine. Total increase over 1874, about 53,073,634 feet.

In 1876.—309,159,972 feet received of all kinds.

The carrying trade in lumber on the coast required a capital of about $12,000,000 annually, and employed a fleet of 123 sailing craft, chiefly schooners and sloops.

WASHINGTON TERRITORY.

A correspondent of the Northwestern Lumberman, (March 17, 1877,) in speaking of the timber resources of Oregon and Washington Territory, says that four fifths of the area, embracing the eastern part, is an agricultural region, the fir timber being limited to the mountain ranges, chiefly along the coast and on the streams tributary to the sound. He says:

> Perhaps the size of some of the trees has been overstated. Perhaps also, the yield per acre for a limited area has not been exaggerated, but the error lies in the supposition that those immense trees are the ordinary growth, and the marvelous yields the average production of the whole Territory. The timber belt on Puget Sound, is about 170 miles long and 30 wide, and of this not more than one third is timbered with fir, there being scarcely any pine in Washington, though the fir is a species of pine. The rest of the timber is hemlock, vine and soft maple, alder, and cedar. The latter is interspersed with the fir, and will in time become valuable, though at present it has little commercial value on the sound. On the highlands the cedar attains a remarkable growth, and is smooth and straight-grained. I saw one tree recently that measured 63 feet in girth; while 120 feet high is no unusual growth. The araa of pine, or fir, is then about 1,700 sections, or 47 townships.

Estimating the yield at 25 M feet per acre as a fair average, the Puget Sound timber region would yield 27,200,000,000 feet of fir, or about equal to the best estimates of standing timber in the lower peninsular of Michigan. Two grades of timber are known in the trade as *sap* and *overgrown*, the former yielding some 7 M feet to the tree, (sometimes not over 2 M), and the latter from 8 to 15 M. The sap fir does not grow as high as the other, which runs to 120 feet without a limb, and sometimes 160 feet. With regard to future lumbering operations, the writer, un-

[1] This account by Professor Newberry was prepared in 1854-'55, in connection with Pacific Railroad surveys.

der notice, remarks, that each successive winter drives the camps further back and up the streams, which has led to a careful investigation of the facilities for floating the logs to the mills, and here is found about the only dark prospect for lumber operations in the Territory. There are but five streams on the south of the Sound in a distance of ninety miles, on an average distance of eighteen miles, the smaller streams not being available, being mountain torrents or rills.

The amount of lumber products shipped from Puget Sound and Oregon to San Francisco, in 1876, amounted to 125,258,520 feet of rough pine; 22,399,121 of dressed; 13,307,703 of pine fencing; and 372,197 pickets. A considerable business was done in spruce, and 474,424 feet of cedar were delivered. The red-wood trade amounted to 120,000,000 feet, and hard wood to 50,000 feet.

The Pacific coast of South America is almost wholly dependent upon our supplies in Washington and Oregon for the timber and lumber used in building. In 1869, they were drawing heavily upon these resources to rebuild the wharves and public works destroyed by earthquakes the year before.[1] England, France, Australia, China, Japan, Mexico, and the Sandwich Islands have also been and still are drawing heavily upon that region for timber supplies.

ALASKA.

Conflicting accounts of the forest resources of this region have been published, some attributing to it extensive and valuable forests of easy access, while others deny that there are any considerable supplies of timber in the immediate vicinity of the coast and in the southern part. A "*Sketch of the Flora of Alaska*," by Prof. J. T. Rothrock, presents a statement drawn from many sources concerning the vegetatien of this region, which, if it does not afford statistical estimates of the amount, gives at least some idea of variety of forest trees in this region,

Of the CONIFERÆ eight species are mentioned: the *Abies Canadensis*, *A. Mertersiana*, *A. Sitchensis*, *A. alba*, *Pinus Cembra*, *P. contorta*, *Thuja excelsa*, and *Juniperus nana*. Of the BETULACEÆ there are six species: *Betula glandulosa*, *B. nana*, *B. Ermanii*, *Alnus viridis*, *A. rubua*, and *A. incana*. The SALICACEÆ are represented by 18 species, all willows, excepting one poplar, the *Populus balsamifera*.

The *Rosaceæ*, embracing 29 species, the CORNACEÆ 4, the CAPRIFOLIACEÆ 4, and MYRTACEÆ 1, are represented by some woody plants and shrubs, but none of them that are of importance in forestry. At the head of Norton Sound a forest of spruce extends nearly to the coast, and occasionally trees are seen on the immediate shore. They are usually from 20 to 45 feet in height, and not more than 1 foot in diameter. Trees 80 to 100 feet occur at the lower Kvichpak, and a little lumber has been sawn at Fort Saint Michaels. The *Abies Douglasii*, *A. Menziesii*, *A. Thuja gigantea*, and *Acer macrophyllum* occur in British Columbia, and doubtless extend into southern Alaska.

About the beginning of the present century, a few Sitka spruces were planted on an island in Iliuliuk Harbor, Unalashka, and in seventy years have become nearly a foot in diameter. Some thirty years later, a few more were planted on another small island in the same harbor, but with poor success. With these feeble exceptions, there has been, it is believed, no attempt at planting in any part of Alaska.

---

[1] *Transactions of California*, State Agricultural Society, 1868–'69, p. 29.

[2] *Annual Report of Smithsonian Institution* 1876, p. 433.

SCHOOLS OF FORESTRY.

The maintenance of timber-supply by cultivation, implies a carefully-devised system of regulations, and competent agents to look after their application. Hence schools of forestry have grown up in every country in Europe in which the general or local governments are the owners and managers of woodlands, and a plan of special training has been devised, usually following a general preliminary course in some college or other approved school, in which the groundwork of preparation is secured. Besides this, a practical acquaintance with the labors of forest-planting and management is in many cases required, by serving for a year, or some other appointed period, under a skilled forester, before entering the forest school. But whether this practical service is required beforehand or not, it always enters into the course of the school, or follows before a regular appointment is given. Certificates of graduation from institutions of approved rank, or corresponding proofs of attainment ascertained by preliminary examinations, are required in all cases; and for those aspiring to the state service, certain other conditions, as to age, nativity, &c., are usually required. The sole aim of these schools being to impart that special information which is needed in the planting and care of forests, the course not only includes the sciences that find their application in this business, but the various details of administration necessary for the proper discharge of these trusts, including official correspondence, the making up of reports, keeping of records, and maintenance of laws and regulations generally, so far as they affect their charge.

The general tendency of this special education is to impress the student with the responsibilities of his profession, and to develop a habit of close observation; and the grades of promotion that are generally before those who deserve them, present motives for fidelity and vigilance that tend to most beneficial results.

The history of schools of forestry goes back in Germany more than a century, and in that country we find the oldest, best-endowed, and in some respects the best-managed institutions of this kind in the world. There are at present nine such establishments in the German Empire, viz, two in Prussia, and one each in Bavaria, Saxony, Wurtemberg, Baden, Hesse Darmstadt, Brunswick, and Saxe Weimar.[1]

---

[1] Much discussion has been had within a few years in Germany upon questions relating to the maintenance of separate forest schools, or their union with the universities. Those who have taken part in these discussions, may be divided into three classes:

1st. Those who strongly maintain the theory that forest instruction should form a part of the university course. They assert that many of the sciences, such as mathematics, physics, chemistry, natural history, botany, &c., are taught with great thoroughness at the universities, and that it would only require certain special professors to adapt the instruction to the precise wants of the student of forestry. The museums, laboratories, libraries, and other facilities are already existing in these institutions sufficient for all purposes.

2d. Those who insist upon the superiority of a separate academy placed in a forest, with a programme of studies strictly applied to the subject of forest culture and management, with practical demonstrations and exercises, for applying directly the precepts of the lecture-room, in the actual care of woodlands in its various details.

3d. Those who would combine the study of forestry with that of agriculture. They have teachers of the pure sciences and something like a University organization; but still they have reference to the practical application of their instruction. They are generally located in or near a large town, and do not have forests of instruction, but generally they have nurseries and experimental stations.

As an example of the first of these, we may mention the University of Giessen, the Polytechnic school at Zurich, and the projected arrangement at the University of Munich; of the second, are the academies of Neustadt-Eberswalde, Münden Eisnach, Nancy, &c., and of the third, establishments for instruction in agriculture and forestry at Hohenheim, Vienna St. Petersburg, and Stockholm.

In the prosecution of inquiries for use in this report, correspondence was had with the officers of nearly all of the schools of forestry in Europe, and a separate account was prepared from documents and information thus obtained, with a view of presenting a statement of the organization of each. But the limits allowed do not admit of their insertion, and we have thought best to give but one of these complete. It is taken without particular intention of preference over others, but rather as a fair example of the general scope and plan of these institutions where managed under the exclusive control of a government, and up to the fullest requirements of the age. The remainder must be reluctantly passed with brief notices, in the hope that fuller opportunity may hereafter be found for doing justice to their merits.

Royal Forest Academies at Neustadt-Eberswalde and Münden, Prussia.[1]

I. NEUSTADT-EBERSWALDE.

As earlyas the close of the eighteenth century, there were, now and then, at the University of Berlin, (if there happened to be qualified persons), lectures given on science of forests, without, however, establishing a permanent professorship for this object, or imposing conditions upon candidates for the public forest service for the completion of their studies in forest science. It was then deemed sufficient to be conversant with the keeping of accounts, mathematics, and the science of natural history, thus entirely leaving technical education to be acquired by practice. The number, however, of qualified employés, thoroughly and systematically educated with regard to technical knowledge, growing, in consequence of this system, constantly less and less, it was deemed proper to establish, in 1821, an academy for forest instruction at Berlin.[2]

Dr. Friedrich Wilhelm Leopold Pfeil, then *Oberforstrath*, was intrusted with the superintendence of this institution, which, although organically not connected, entered into such association with the university, as to employ the professors and means of instruction belonging to the latter, for teaching the fundamental and accessory sciences, while the lectures on the principal study were given by technical instructors. This organization, however, soon proved inadequate. On the one hand the much-extended study of the fundamental and accessory sciences produced an injurious effect upon the principal studies, and, on the other, there being no suitable forests in the immediate neighborhood of Berlin, the theoretical lectures could not be explained, nor supplied with practical illustration. The more distant but unfrequent excursions and forest journeys, could not efficiently remedy this inconvenience, and proved insufficient to secure a close connection between the theoretic study and the living intuition of the forest.

On the superintendent's advice, based upon these motives, and strongly supported by the kind intercession of Wilhelm and Alexander von Humboldt, the academy was, in 1830, removed to Neustadt-Eberswalde, and named the High Institution for Forest Science. In immediate neighborhood of this place, there are two large forest districts which offer the students in high degree, a fine opportunity for becoming familiar with their various features. Dr. Pfeil continued to act as superintendent, and, at the same time, was intrusted with the administration of said districts. In addition to Pfeil, who taught the science of forestry proper, there were appointed two other professors, one for the whole department of natural sciences and the other for both mathematics and geodesy. In 1830 a chair was established for Prussian jurisprudence, with particular reference to forest matters, and, in 1851, a second teacher of forest science was appointed. Pfeil remained in his position as superintendent, till the fall 1856, when he was succeeded by *Oberforstmeister* Grunert. After the latter's resuming his former position near the administration of public forests, the direction of the institution was conferred upon Dr. Danckelmann, the present incumbent. Since 1866 very important changes have taken place in the organization of the academy, with a large increase in

---

[1] We are indebted to Dr. J. Danckelmann, the director, for the historical sketch, a translation of which is here given, as also for a series of documents relating to examinations and other matters concerning the forest service of Prussia.

[2] It is said that in consequence of continual discussions with Hartig and Reuss, directors-general—Pfiel desired to have the forestry department, in which he was a professor, removed from Berlin; and that by the aid of the two Humboldts he interested the ministry in his behalf, and finally succeeded in obtaining the transfer. Notwithstanding this, those who are destined for the superior functions of inspection and conversation, must, besides their two years and a half at the school, follow a course of some years at the university.—(*See Revue des Eaux et Forêts*, May, 1876.

number of instructors. At present, there are officiating at the academy, besides the director, who occupies the first chair for forest science, two more teachers of this science, a teacher of mathematics, physics, mechanics, and meteorology, one of chemistry, mineralogy and geognosy, one of botany, one of zoölogy, and one of jurisprudence, and, in addition, a royal chief forest officer, as assistant teacher of construction of roads, geodesy, and plan-drawing, and also a chemist as assistant teacher of geology.

As it may afford some interest in mentioning the number of hours assigned during the five term-times to the different lectures, we give the following table:

Fundamental sciences.	
Objects of instruction.	Whole number of hours.
NATURAL SCIENCES.	
General and theoretic chemistry	32
Special inorganic and organic chemistry applied	80
Physics and meteorology	80
Mineralogy and geognosy	60
Definition of minerals and rocks	20
Reviews for inorganic natural sciences	16
Botany in general, and forest botany in particular	64
Anatomy of plants, vegetable physiology and pathology	60
Microscopy	20
Botanical reviews	20
Botanical excursions, each two and a half hours	80
General zoology	16
Vertebrates	80
Invertebrates, with special reference to forest insects	80
Zoological preparations	16
Zoological reviews	20
Zoological excursions, each three hours	96
Total natural sciences	840
MATHEMATICS.	
Geodesy	72
Interest and rent account	20
Wood-measuring	20
Mathematical reviews and exercises	56
Surveying and leveling exercises, each four hours	192
Plan-drawing exercises, two and a half hours	80
Total mathematics	440
ECONOMICAL SCIENCES.	
Public economy and finances	48
Total sum of hours for fundamental sciences	1,328

Principal sciences.	
Objects of instruction.	Whole number of hours.
Cultivation of forests	80
Forest implements	20
Geograph forest botany	48
Protection of forests	32
Forest usufruct and technology	80
Forest surveying	20
Appraising forests	80
Calculation of the value of forests and forest statistics	32
Administration of forest and hunting	48
Redemption of rights of usage	32
Forest history	40
Forest statistics	20
Review of various forest matters	56
Examinations	40
Forest excursions, each four hours	352
Total	980

Secondary sciences.	
Objects of instruction.	Whole number of hours.
JURISPRUDENCE.	
Civil law	72
Criminal law	32
Civil and criminal law-suits and constitutional rights	40
Jurisprudence	36
Total	180
Construction of roads	32
Hunting	32
Shooting exercises, two hours each	96
Total sum of hours for secondary sciences	340
Grand total	2,648
Percentage of fundamental sciences	50
Percentage of principal sciences	37
Percentage of secondary sciences	13
Average per instruction week (21 in winter, 17 during summer): $\frac{2648}{93}=28.5$ hours, or per day, 4.9 hours.	

It is interesting to study by what phases the course of instruction has passed from the origin of this school to 1873. They have been as follows:

Number of hours devoted to instruction.

Programme of subjects.	Two years' course.						Course of two years and a half.	
	1834–'36.		1844–'46.		1860-'62.		1873–'75.	
	Hours.	Per cent.	Hours.	Per cent.	Hours.	Per cent.	Hours.	Per cent.
Inorganic natural history..	188	6	168	6	220	8	288	11
Botany	396	18	354	14	348	12	244	9
Zoology.....................	326	15	332	18	332	11	308	12
Total natural history ..	910	39	854	38	900	31	840	32
Mathematical sciences.....	406	19	618	24	698	26	440	17
Economical sciences	54	2	36	1	36	1	48	1
Total for the fundamental sciences	1,370	60	1,568	63	1,634	58	1,328	50
Law, forest ecomony.......	814	38	904	30	992	35	980	37
Law	....	....	152	6	172	6	180	7
Forest construction.........	....	....	....	....	....	....	32	1
Hunting	40	2	40	1	40	1	32	1
Exercise with gun	....	....	....	....	....	....	96	4
Total for accessory instruction	40	2	192	7	212	7	340	13
General total	2,224	100	2,604	100	2,838	100	2,648	100
Time of teaching per day ..	4.8	....	4.8	....	6.2	....	4.8	....

A fact is developed by this table which is noticed in many other institutions, that the two years' course had become crowded by the unavoidable development of new studies, so that before the enlargement to five semesters, the recitations and exercises occupied 6.2 hours each day, besides the time given to study. This requirement was too much, and could not fail, if continued, to bring lassitude and inattention. The course of law was introduced in 1844, and that of forest constructions in 1873. Professor Mathieu, of Nancy (from whose article in the *Revue des Eaux et Forêts* 1874, p. 155 the above table is derived), remarks concerning the more recent addition of studies as follows:

"We would specify among other subjects recently added to the programme of studies at Neustadt-Eberswalde, microscopic examinations of vegetable tissues, a general knowledge of the lower organizations, which, from their parasitic habits, are a determinate cause of a great number of maladies in plants and animals, and which are likewise agents in fermentation. Furthermore, we might specify the elements of organic chemistry, which are indispensable to an understanding of the laws of vegetable physiology; some ideas of forest-statistics, one of the principal and most urgent of the desiderata of every well-ordered administration; a glance at the history of forests, and of the various phases through which the sciences relating to it have passed; and, finally, the elements of meteorology, which, by setting the forest agents to the pursuing of observations of this kind, will lead us to a certain knowledge of the influence still so controverted, as to the influence of the forests upon the climate of a country, and upon the delivery and maintenance of the sources of supply of the water which fertilizes it. All these new ideas are doubtless useful, and may, without difficulty, be included in our course of forest instruction."

Since 1872, the principal station for experiments relating to forest matters in Prussia, on which there is conferred, at the same time, the management of the transactions of the Association for German Experimenal Stations relating to Forest Matters, is connected with the academy at Neustadt-Eberswalde in this way, that the latter's superintendent is also the director of the principal station, and that, under his direction, the instructors of the academy are elaborating the different divisions of the experimental work, viz, the forest technical, the chemical, physical, the meteorological, the zoölogical observations, and also what relates to physiology of plants.

This opens, on one hand, a large field of scientific researches to the teachers, putting at their disposal new teaching matter, and gives, on the other hand, to students the

opportunity of studying how to prepare the scientific solution of interesting and important problems, and of taking their own share in the respective elaborations.[1]

The results of active instruction at this academy during the forty-six years of its existence are highly satisfactory. Almost all the Prussian employés near the administration of public forests—without, however, counting those from the provinces added to Prussia in 1866, and who entered into Prussian service—owe their perfection in forest science to this academy. Besides a considerable number of private forest officers and forest proprietors of the country have here acquired the necessary skill in administering their own forests or those committed to their charge. Finally, many foreigners have applied themselves at this academy to the study of forest science. The following table, showing the annual number of students from 1830 to 1876, may be of good service in judging of the academy's operation:

Attendance at the Forest Academy of Neustadt-Eberswalde.

Years.	Semesters.		Years.	Semesters.		Years.	Semesters.		Years.	Semesters.	
	Summer.	Winter.		Summer.	Winter.		Summer.	Winter.		Summer.	Winter.
1830	39	36	1842	37	42	1854	84	84	1866	66	45
1831	30	29	1843	51	48	1855	83	76	1867	72	79
1832	23	23	1844	51	47	1856	62	65	1868	93	63
1833	28	21	1845	52	63	1857	57	64	1869	64	67
1834	36	30	1846	66	65	1858	72	67	1870	66	(a)
1835	36	29	1847	71	72	1859	68	54	1871	62	66
1836	36	32	1848	68	81	1860	44	51	1872	61	63
1837	33	32	1849	78	83	1861	53	55	1873	57	52
1838	40	41	1850	84	86	1862	47	38	1874	68	45
1839	45	40	1851	80	85	1863	33	32	1875	68	50
1840	40	34	1852	81	80	1864	36	42	1876	66	50
1841	40	45	1853	84	84	1865	57	59	Average	57	54

(*a*) Closed on account of war.

This place is about twenty-four miles northeast of Berlin. There is connected with it a drying-house for seeds, extensive seed-beds and nurseries, specimens of trees in great variety for botanical study, including many of the rarer kinds, and a museum rich in specimens of birds, animals, and insects found in forests, very neatly arranged in cases.[2]

[1] The division of these experiments among the different officers of the academy is as follows: Forest division, Forstmeister Bernhardt; meteorology, Prof. Dr. Müttrich; chemical and physical division, Prof. Schülz; vegetable physiology, Prof. Dr. Hartig; zoology, Prof. Dr. Altum. Oberforste-candidate Eberts assists in the forest division. Forstmeister Gerding is assistant in the meteorological division.

[2] Captain Campbell Walker, now chief conservator of forests in New Zealand, in writing an account of a visit to this place, concerning the arrangement of the museum, &c., says:

"Where an animal or insect does damage to trees, specimens of the branch, bark, leaf, wood, or cone in a healthy state, and after being attacked, are exhibited close to each other, so that the student can see at a glance the nature of the damage, and connect it with the animal that causes it. Thus we have squirrels, rats, beavers, and mice set up so as to represent nature, gnawing at the barks, grubbing at the roots, &c. Insects are shown in the several stages of their existence, larva, chrysalis, caterpillar, or moth, with their ramifications in the stems or branches of the tree. These, with specimen blocks of almost all descriptions of timber, form a most instructive and interesting collection, in which much time could be spent with advantage.

"Nothing struck me as more remarkable, than the extent and varied nature of the studies required from forest candidates or probationers in Prussia, and the number of years they are contented to spend, first in studying, and then in waiting for an appointment. The would-be *Oberförster*, which is the lowest of what we would call the 'gazette appointments,' must, after passing certain terms at a government school of the first class, spend a year with an *Oberförster* in a *Revier*, and then pass an examination at a forest academy, and an examination in scientific forestry, land-surveying, &c., on passing which the pupil becomes a '*Forstkandidat;*'—then another two years of practical study, during at least nine months of which he must actually perform the duties of a forester, after which comes the final government examination, on passing

II. ROYAL FOREST ACADEMY AT MÜNDEN.

This was inaugurated April 27, 1868, under Dr. Gustav Heyer, as director, and is subject to the general supervision of the Ministry of Finances. The statutes and regulations are the same as at Neustadt-Eberswalde. The attendance since 1868 has been as follows:

Years.	Summer semester.	Winter semester.	Years.	Summer semester.	Winter semester.
1868	44	52	1874	113	86
1869	60	61	1875	106	61
1870	62	75	1876	78	
1871	64	78			
1872	81	....	Average	78	70
1873	83	74			

Royal Central Forest Academy at Aschaffenburg (Bavaria).

A former forest institute, (dissolved in 1832), was newly organized in 1845, under the Bavarian Ministry of Finances. Course, two and one-half years. On the 30th of March, 1874, the government decided to unite this school with the University of Munich, but the necessary appropriations for carrying this into effect had not been made at the time of our receiving returns. A memorial volume relating to this school has been published. Good service has been done to science by experiment and observation at this station.

Royal Saxon Forest Academy at Tharand.

The germ of this school began at Zillbach, where in 1786, Heinrich Cotta began to teach forestry. In 1795, it became more formally an institution of learning, and in 1811 it was removed to Tharandt. In March, 1816, it became a public institution. In 1830 a department of agriculture was annexed, but in 1870 this was removed, and it has since remained a school of forestry only. From the ample details received

which he enters the grade of *Oberförster-kandidat.* The difference between the two examinations is explained to be, that the first tests the candidate's knowledge of theoretical forestry and cognate sciences, while the latter tests his ability to apply what he has learned, and capability for employment as *Oberförster* and in the higher grades.

"After passing the final examination, the *Oberförster-kandidat* is employed as an assistant in the academies and control-offices, in making forest-surveys and working-plans, and sometimes acting in charge of a *Revier*, receiving certain daily or weekly allowances while so employed. After five or six years of this probation, he may look forward to being permanently appointed. Thus we have at least five years spent in study, and another five years in probation, the former without pay and the latter only with meager allowances while actually employed, before the would-be forest-officer is installed; and the time is generally much longer. Yet so great is the desire for government service, and particularly forest-service, in Prussia, and indeed in Germany generally, that there is no lack of competitors."

It is stated from information a few years ago that there were not less than 33 barons or baronets who held appointments in the crown-forests of Prussia.—(*Brown's School of Forestry in Europe*, 1877, p. 11.)

The library of this institution has a published catalogue which shows 2,349 titles. The collection of woods, by Dr. Robert Harting (third of the name), a professor at the school, is prepared as blocks about a foot long, representing an entire section of the trunk with the bark on. They are cut longitudinally into three pieces, of which one section is through the center, and another parallel with this and of course tangent to some of the circles of growth. One side shows the natural wood and the other a varnished surface, and the three are united by hinges, so as to open and close like a book.

from the director, Dr. J. F. Judeich, we can only insert the following tables of attendance:

Periods.	Forestry department.						Agricultural department.					
	Saxon.			Foreign.			Saxon.			Foreign.		
	Max.	Min.	Average.	Max.	Min.	Average.	Max.	Min.	Average.	Max.	Min.	Average.
1816–'29	65	25	37	36	11	22	......	......	......	......	......	......
1830–'45	42	9	24	25	10	17	23	3	12	21	1	14
1846–'51	37	10	25	28	14	23	12	3	8	15	2	6
1851–'65	38	12	21	47	21	30	20	4	11	46	9	23
Whole period	65	9	27	47	10	22	23	3	11	46	1	12

Years.	Summer semester.								Winter semester.							
	Forestry department.			Agricultural department.		Total.			Forestry department.			Agricultural department.		Total.		
	Saxons.								Saxons.							
	Designing to enter Saxon service.	Not designing to enter Saxon service.	Foreigners.	Saxons.	Foreigners.	Saxons.	Foreigners.	General total.	Designing to enter Saxon service.	Not designing to enter Saxon service.	Foreigners.	Saxons.	Foreigners.	Saxons.	Foreigners.	Total.
1866	42	13	20	5	12	60	32	92	43	13	19	5	8	61	27	88
1867	44	21	24	4	8	69	32	101	44	20	23	3	11	67	34	101
1868	35	17	24	3	8	55	32	87	34	15	25	2	10	51	35	86
1869	17	12	18	1	7	30	25	55	17	9	26	......	6	26	32	58
1870	14	6	23	......	......	......	......	43	13	6	30	......	......	......	......	49
1871	24	4	26	......	......	......	......	54	22	4	29	......	......	......	......	55
1872	29	3	28	......	......	......	......	60	29	7	25	......	......	......	......	61
1873	14	3	18	......	......	......	......	35	18	5	30	......	......	......	......	53
1874	15	5	32	......	......	......	......	52	20	9	34	......	......	......	......	63
1875	12	8	26	......	......	......	......	46	17	13	45	......	......	......	......	75

ROYAL AGRICULTURAL AND FORESTAL ACADEMY OF WURTEMBERG, AT HOHENHEIM.

This institution was founded July 2, 1818,[1] and was reorganized September 9, 1865. It embraces a very full course of instruction, both in agriculture and forestry, and is under the care of the Ministry of Education and Religion. It is located at a place about two hours' ride from Stuttgart, in premises once a princely residence, with a superb park of eight hectares, containing many grand old trees and extensive gardens filled with native and exotic trees and plants. It has connected with it 315 hectares of land devoted to agriculture, and 2,200 hectares are given to forestry. Its collections are extensive and valuable, and it has experimental stations for prosecuting agricultural and forestal observations, including meteorology.

Besides a director, it has nine regular lecturers, seven adjunct professors, two reviewers, and one assistant, and the course embraces five semesters, or two years and a half. The time for completing the course is, however, not fixed, and may be finished in less time, if attainments

[1] In the beginning there were two separate institutions, both founded in 1818, and united June 29, 1820.

are shown. The object of the academy is to impart a thorough practical and professional education to those who are to become the owners or managers of estates, and to farmers and foresters in public or private service, and to enable them to become champions of progress among their colleagues in business.[1]

FORESTRY IN THE UNIVERSITY OF TÜBINGEN.

Since 1817, the University of Tübingen has had a chair of agriculture and forestry in its faculty for state economy. It has for its object to furnish students with the knowledge necessary for employment in financial and administrative affairs, and therefore only the more important points of information are presented in the lectures, but they penetrate deeper into the spirit of the different systems of agricultural and forestal economy, with the view of pointing out the motives concerned, and in this manner of rendering their relations to financial matters and to the public interests more fully understood.[2]

POLYTECHNIC SCHOOL AT CARLSRUHE, BADEN.[3]

This school (established in 1832) has a department of forestry at which from 30 to 45 students attend, of whom about one-fifth are foreigners.

FOREST INSTITUTE IN THE UNIVERSITY OF GIESSEN.

A separate school of forestry was established at Giessen, in Hesse-Darmstadt, by an ordinance dated March 24, 1825, and on the 14th of June, 1831, it was united with the "Ludewigs Universität," of that place, of which it forms at present the fourteenth department. It is under the supervision of the university authorities and of the minister

[1]An account of this academy at Hohenheim is given in detail in the publication relating to the meeting of German agriculturists and foresters at Stuttgart in 1842, under the title of "*Die Königliche Würtembergische Lehranstalt für Land- und Forstwirthschaft in Hohenheim*"; also in a publication in 1863, "*Die Land- und Forstwirthschaftlische Akademie, Hohenheim*," and in the published account of the semi-centennial celebration of the institution, held November 20, 1868, under the special title of "*Geschichtliches über die Land- und Forstwirthschaftliche Akademie, Hohenheim, von Professor Dr. V. Fleischer.*" A concise notice is also given in a pamphlet prepared for the Vienna exhibition of 1873, "*Der Höhere Landwirthschaftliche Unterricht in Würtemberg,*" by Prof. Walter Funke. An account of the organization of this academy is also given in *The Journal of Forestry*, i, p. 80, in an article written by the Rev. J. Croumbie Brown, LL.D., which was also separately published.

Professor Mathieu, of Nancy, in describing this institution, says: "The little kingdom of Wurtemberg, with scarcely two millions of inhabitants, has spared nothing in providing it with whatever could contribute to the success of instruction or to the progress of science. This truly liberal spirit has led to the establishment of magnificent agricultural galleries, where we find collected, to the number of sixteen hundred, the various tools and machines employed in labors of the field; elegant rooms filled with forestal collections, implements, woods, and various products; cabinets in botany, zoölogy, mineralogy, and geology; instruments for use in studies of physics and for geodesy; a station for experiments concerning woods, and another for meteorology. Its library numbers 5,500 volumes, and its reading-room contains numerous periodicals in all languages, of which 49 were scientific, agricultural, or forestal journals, and 35 were of the political, literary, or illustrated class."—(*Revue des Eaux et Forêts*, 1874, p. 194.)

[2] This course of instruction would present little of interest in the practical business of the forester, as compared with the abundant facilities and broad plan of education afforded at the school at Hohenheim. Many of the students of the latter find it, however, to their advantage to attend for some time the lectures of the university for the purpose of gaining a fuller knowledge of the auxiliary sciences.

[3] The requirements for admission are as follows: Citizens of the state, who wish to

of the interior. The corps of instruction consists of a director, a provisional assistant, and a superintendent of the garden.[1]

DUCAL POLYTECHNIC SCHOOL OF BRUNSWICK.

The ducal *Collegium Carolinum* was founded in 1745 by the Duke Charles I, as an institution intermediate between the gymnasium and the university. It was essentially a polytechnic school, and the first of its kind in the world.[2] In 1835 it modified to meet the requirements of science. According to a plan of studies arranged in April, 1872, the course of instruction was arranged in five special departments, of which forestry is the sixth. The latter was reärranged in October, 1875, by extending the course of instruction from two years to two and a half, to enable the students to devote the first half year to the preliminary studies necessary for their practical apprenticeship of a year and a half

---

enter the State forestry service, after attending a full course at the gymnasium, are admitted, and must pass through a course of four years, of which the first two are devoted to those fundamental and auxiliary studies which do not relate directly to forest science, but which serve as a preparation for the remaining two which embrace the forest course proper. Foreigners may attend the first two years or not, as they prefer. The least age of admission is 17 years. At the close of the second year the State students must pass an examination in natural philosophy and mathematics, and if they fail they are allowed one more trial. This examination entitles them to enter upon the last two years of special forest studies in which they are taught agriculture, forest jurisprudence, and the higher mathematics, when they are again examined, and if passed, are qualified for a place in the state service. The examination at the end of the first two years is by the professors of the polytechnic school, and the final one by the forest directors, a person skilled in law, a professor of agriculture, one of forest management, and two professors of mathematics.

After passing all examinations the candidate is assigned to the general district foresters as an assistant, to enable him to become practically acquainted with his duties, and he receives a tract of forest to manage. After six to ten years, according to the number waiting, he gets a position as general district forester. The number of these districts in Baden is at present 110, and about four of these appointments are made annually. The Forestry Direction has its seat in Carlsruhe, and is composed of six members, who are inspectors.

The aids to instruction at this forest school are a valuable collection of objects pertaining to the subject, a chemical and physiological laboratory, to which a greenhouse is annexed, and a forest-garden.

The area of forests in Baden is 510,924 hectares (1,262,493 acres).

[1] The fundamental and auxiliary sciences, mathematics, natural sciences, chemistry, agriculture, law, &c., are taught by other professors of the university, while those studies that immediately relate to forestry come within the care of this special department. These include the encyclopedia and methodology of forest science, in connection with a historical introduction, and special consideration of forest statistics (for foresters, financial economists, and agriculturists), forest protection, forest economy, and forest technology in connection with excursions, sylviculture with exercises and excursions, forest administration, regulation of forest reserves, and state forest economy. These are under the care of the director. The laying out of wood-roads, with demonstrations and exercises, including calculations of the value of forests, surveying, measurement of woods, &c., are taught by the assistant, Prof. T. Lorey, and are illustrated by practical exercises.

The academic forest-garden occupies six hectares, and Giessen and Schiffenburg forest-reviers in the neighborhood afford opportunities for practical study. The course of instruction extends through two years. Two excursions are made weekly, at which the subject of the lectures is practically illustrated, and the various operations of sylviculture are shown. Besides these there are journeys of one or two weeks at a time in summer, under the guidance of one of the teachers. The students of the forest institute enjoy the same rights as those of the university. The usual certificates as to age, residence, previous attendance at a gymnasium, or an institution of similar grade, are required. Foreign students are expected to have a sufficient amount of prepara-

[2] The Real Academy of Vienna begun in 1770; the Polytechnic School at Paris, in 1795; the Royal Polytechnic Land Institution, at Prague, in 1810, and the Polytechnic Institution at Vienna, in 1815.

in the forests. This is followed by an uninterrupted theoretical course of two years. The need of this change had been for some time felt.[1]

The aids to education in this department are:

(1.) A collection of instruments employed in forestry; implements for wood-working; measuring instruments; models for technical work in wood-products; making of coal-pits, drying-ovens, and coal-kilns, &c.; a collection of hunting implements and apparatus.

(2.) A forest-garden of 10 waldmorgen ($8\frac{1}{4}$ acres), near Riddagshausen.

GRAND DUCAL FOREST SCHOOL AT EISENACH, SAXE-WEIMAR.

This institution was founded in 1808 by the late Oberforstrath König, at first as a private enterprise at Ruhla, but in 1830 it was adopted as a state institution and has since been under state control.

Forests for instruction, Eisenach, Wilhelmsthal, and Ruhla. The course of instruction embraces two years. In the forestal lectures, excursions, and practical exercises of the summer semester foreign students of forestry may participate.

FOREST-EDUCATION IN AUSTRIA.

The present organization in Austria provides three grades of institutions for instruction in forestry, viz: The Imperial High School of Agriculture and Forestry at Vienna, Middle Schools, and Lower Schools.[2]

---

tory education, but are not required to bring the certificates like those expected from native Hessians. The statutes of the university prescribe, in detail, the examinations to be passed for literary degrees, but our limits will not permit us to include them in this connection.

Native Hessians must bear two examinations, the preliminary and the departmental. The first of these comprises mathematics, including algebra, geometry, and the elements of differential and integral calculus, physics, in cluding mechanics, and chemistry, and may be passed by the student without reference to the duration of his attendance at the university. The departmental examination comprises every branch of forestal science, besides botany, national economy, and agriculture.

We are indebted to Dr. Richard Hess (director since 1868) for documents and other information relating to this institution. The attendance has been as follows since 1869:

Years.	Summer semester.			Winter semester.		
	Natives.	Foreigners.	Total.	Natives.	Foreigners.	Total.
1869	12	2	14	10	2	12
1870	7	2	9	9	1	10
1871	13	1	14	16	0	16
1872	16	3	19	16	3	13
1873	16	4	20	16	5	21
1874	16	6	22	15	5	20
1875	11	5	16	9	3	12
1876	9	5	14	7	2	9
Average	12.5	3.5	16.0	12.25	2.6	14.1

[1] *Ueber den Forstlichen Unterricht an polytechnischen Lehranstaten. Braunschwig*, 1862.

[2] In 1833 a forest academy was established at Mariabrunn, the premises occupied being an old monastery near Schoenbrunn, in the suburbs of Vienna. It was at the entrance of the beautiful mountain forest of Wienerwold, and its ample buildings furnished abundant facilities for every purpose of instruction, including laboratories and collections. It was reorganized in 1867, made an experimental station in 1872, and discontinued in 1875, under a decree dated April 10, 1872, establishing the High School of Agriculture at Vienna. The forest section of the institution was opened October 12, 1875, taking the place of that at Mariabrunn.

The course of instruction before the change occupied three years, and in the fund-

The Imperial High School of Agriculture and Forestry, at Vienna, was founded by a law of April 30, 1872. The agricultural section was opened April 1 of that year, and the forest section October 1?, 1875.

The object of the high school of agriculture at Vienna is the maintenance at state expense of an institution for instruction in the highest departments of agriculture and forestry. It therefore offers corresponding opportunities for the preparation of those who have the care of large estates or domains, as also for instruction and researches in agricultural and forestal affairs, and enables students of state economy and jurisprudence to obtain for their future calling valuable knowledge in agriculture. The high school of agriculture is divided into two sections under one management, the agricultural and forestal.[1]

Secondary schools of forestry in Austria-Hungary.—Of these there are three, viz, at Weisswasser in Bohemia, at Eulenberg in Moravia, and at Lemberg, in Galicia.

FORSTLEHRANSTALT ZU WEISSWASSER.—Course 2 years; instruction in German; condition of admission, certificate of a lower real-school and one year's forest practice; minimum age, 17. Teachers, 5; registered scholars first year, 42; second year, 38; total, 80. It has a library—various collections; a botanical garden of 1.5 hectare; a leaf-

---

amental and accessory sciences, was designed chiefly as a preparation for special forest studies, in which the course was very complete. The institution was wholly at the charge and under the direction of the government, and was open to any who might be able to pass the preliminary examinations. The student could pursue one or two branches only, or all three in succession. The attendance was not large, and averaged about twenty-six. Without going into minute details, it may be stated that the number of hours devoted to the several classes of studies, during the first two years, was as follows:

	1st year.	2d year.
Mathematics	672	609
Natural sciences	588	168
Forestal sciences	168	441
Total	1,428	1,218

During the third year 409 hours were given to administrative instruction, and 735 to forest-industries, making 1,237 hours for that year, or 3,880 for the whole course of three years. This divided among 126 weeks, gave 30 hours to the week, or 5 hours daily. The percentage was 49 per cent. for mathematics, 23 per cent. for natural sciences, 14 per cent. for forestal sciences, and 13 per cent. for administrative instruction.

Professor Mathieu, in writing concerning this school in 1874, remarks: "This organization may be suited to the wants of this country, but the stranger not acquainted with it must be astonished at the enormous development of the mathematical portion, including applications to geodesy, mechanics, and constructions, while the forest-sciences proper appear thrown into the background. Only 546 hours are given to these in three years, while at the German school at Neustadt Eberswalde they occupy 980 hours, in a course of two years and a half." He also notices the absence of instruction in amenagement, mineralogy, geology, and other studies deemed important elsewhere, and only a partial representation of zoology, except as it related to the chase and to noxious animals.—*Revue des Eaux et Forêts* (1874), p. 244.

[1] The instruction comprises all those departments of science which have for their object the highest culture in the sphere of agriculture, and is so arranged that the course may be finished in six semesters. The plan of instruction admits of two classes of hearers, ordinary and extraordinary. The former must produce a legalized certificate of completion of course in a gymnasium or upper real-school. To ordinary hearers of department schools of the same rank, on producing a certificate to that effect, admission may be granted. The ministry decides in each case the rank of such schools. Persons not legally qualified as above may be admitted as extraordinary hearers, if they have reached their eighteenth year, and are able to show a degree of preparatory education that will enable them to understand the lectures of the institution. Extraordinary hearers have no claim to exemption from tuitions, or to the enjoyment of state stipends. Strangers may be admitted to the lectures and demonstrations upon notice by the lecturers being given to the dean. Proof of preliminary preparation is not required of them, nor do they receive certificates. All hearers are under the disciplinary regulations established for the high school.

wood of half a hectare; an evergreen plantation of 0.2 hectare; and a forest of instruction of 1,175 hectare. Tuition 40 florins. The Bohemian Forest School Society pays 2 stipends of 200 florins, and 2 of 150, besides other aid by private gentlemen. For repairs, apparatus, &c., 494 florins.

This school was founded in 1855 by Bohemian *Forstverein*. In 1862 it was reorganized and adopted by the Bohemian *Forst-schulverein*, which defrays all the expenses.

2. MORAVIA-SILESIA FOREST SCHOOL AT EULENBERG.—Founded in 1852, by Moravia-Silesia Forest School Society. Course two years; instruction in German. With this institution is connected a general boarding-school for all scholars. Teachers, 5—4 ordinary and one assistant. Scholars in 1875–'76, 43. It has a library of 1,500 volumes, cabinets and collections of various kinds, a forest of instruction, three nurseries and a botanical garden; in all 691 hectares. There are 6 stipends, amounting in all to 2,140 florins. Total ordinary expenses, 10,640 florins, of which 5,948 are for salaries. The Moravian administration pays 2,100, and the Silesian 300 florins; the remaining expenses are paid by the Moravia-Silesia Forest School Society. Receipts from tuition in 1874–'75, 1,060 florins.[1]

3. GALICIAN STATE INSTITUTION FOR FOREST INSTRUCTION AT LEMBERG.—Founded in 1874; course two years; instruction in Polish, with the adoption of German terminology, and German exercises; conditions of admission; examination or certificate of lower real-school or lower gymnasium; age 17; school year from October 1 to last of July; study hours per week, 30 hours for theory; excursions or practical exercises every Saturday; teachers, 9—2 ordinary, 6 auxiliary, and 1 adjunct; scholars in 1875–'76, 78; library, 520 volumes; cabinets and collections of various kinds, and a small seed and plant nursery. It has a botanical garden and a forest of instruction of 1,344 jock, and a field for experiments of 5 jock. Total expenses, 10,800 florins, of which 7,800 are for salaries. Contributions from the state 5,000 florins; from the province, 5,800. Receipts from tuition in 1874–'75, 110 florins.

Lower schools of forestry in Austria-Hungary.—Of these there are two mentioned in official reports of the Ministry of Agriculture.

1. SCHOOL FOR FOREST CULTURE OF THE FOREST SCHOOL SOCIETY OF LOWER AUSTRIA, AT AGGSBACH, NEAR MELK, IN LOWER AUSTRIA.—Founded in 1875; course one year; instruction in German; boarding arrangements calculated for 20 scholars; conditions for admission, a finished course at a lower real-school or gymnasium, or a complete citizen-school course with satisfactory results. One year forest practice; age, 15 years; school year from September 15 to August 15. Opened for instruction January 3, 1876; teachers 2, the director and his assistant; number of scholars, 16. It has a small library, and the beginnings of collections; a forest of instruction of 740 hectares; nursery of 0.31 hectares.

2. SCHOOL FOR FOREST CULTURE OF THE IMPERIALLY PRIVILEGED STOCK COMPANY OF THE INNESBERG MANUFACTURING COMPANY, AT WILDALPEN, IN STYRIA.—Founded in 1874; course, two years; instruction in German; boarding facilities for 16 scholars.

The conditions of admission are, a finished common school education and age 16 years. From October 15 to April 15, 32 hours are given

[1] This institution was suggested by Forest Inspector Friedrich Bechtel early in 1850. It was incorporated February 3, 1852. The average attendance during the first twenty-five years was 23.

every week to instruction; the rest of the year to practice. There are 4 teachers, of whom 1 is an assistant. Scholars in 1875–'76, 8. It has a small library and collections. Tuition free; board and lodging, 180 florins. Common expenses of the school, about 2,770 florins, of which 800 are for salaries. Extraordinary expenses, 221 florins. Contributions from individuals, 842; the remainder by the company under whose patronage the school is sustained.

In addition to the foregoing, from the official reports of the ministry of agriculture, we find the following schools of forestry in Austria:

SCHOOL OF AGRICULTURE AND FORESTRY AT KREUTZ, CROATIA.—Located in the Kreutz, or Krizevz, the capital of a district of the same name, with a railroad station and 3,000 inhabitants, in a beautiful location between the navigable rivers of the Drave and Save, there exists for the kingdom of Croatia and Slavonia a school for agriculture and forestry as a state institution.

This school was opened in the presence of Government Commissioner Baltis, who had labored much for its foundation, November 19, 1860. It was expected that at the end of 1877 there 84 forest students would have been graduated.

One year of forest practice and completion of course in a lower gymnasium or lower real school, in Austria, required on admission. Expenses, 100 Austrian gulden per annum.

The institution has a director and four professors. Its collections in forestry, mathematical and surveying instruments, are valued at 6,000 florins, and its library the same. It has a forest of instruction of 170 yocks, or 87 hectares, with oaks reaching 250 years of age. The oak of this forest is worked in periods of 100 years. The course of instruction was formerly two years. It is now three.

ROYAL HUNGARIAN MINING AND FOREST ACADEMY AT SCHEMNITZ.—A school of mines was founded in 1765 in the mining district of Schemnitz, and regularly established in 1770. In 1807 a forest institute was commenced under Dr. Heinrich David Wilckens, and on the 5th of January, 1808, it received a regular charter. A re-organization of the mining and forest academy was effected in 1846 and again in 1872. The course of instruction is now divided into six classes of studies, viz: 1. Mining; 2. Metal-furnace construction; 3. Iron-furnace construction; 4. Machinery used in mining and metallurgy; 5. Forestry; 6. Forest engineering. In 1870 the institution celebrated its first centennial, and the year following published a memorial volume giving a historical account of its career and a full statement of present condition. The course continues four years, of which the first two are devoted to general and preliminary studies, and the last two to special objects.[1]

[1] The memorial volume gives a list of graduates from the beginning—their nationality and occupation followed. The aggregate gives, Hungarian, 2,958; Austria-Slavonian, 2,205; foreign, 93; nationality unknown, 116. Total, 5,373. Since 1870 the attendance has been as follows:

Year.	Ordinary.	Extraordinary.	Strangers.	Total.
1871–'72	57	2	11	70
1872–'73	91	2	3	96
1873–'74	119	5	....	124
1874–'75	139	8	....	147
1875–'76	159	11	....	170
1876–'77	173	17	....	190

We are indebted to the director, Prof. Stefan Farbaky, for ample information concerning this institution.

An elementary school of forestry was established at Schneeberg, in Krain, in 1869, and one at Hinterbruhl, near Vienna, in 1865.

FORESTRY INSTRUCTION IN SWITZERLAND.

The *Schweizerische Forstschule in Zurich* forms the fifth division of the Federal Polytechnic Institution at that place, and was opened in October, 1855. It embraces instruction in architecture, engineering, mechanical, technical, and chemical applications of the sciences to forestry, and a general division of philosophy and political economy. In October, 1871, this school was extended to embrace agriculture. The institution is under the federal department of the interior, and the president of the school council is at present Dr. Kappeler, as its standing representative, and the directors of the several divisions are appointed by the federal council of education. Prof. E. Landoldt is at the head of the forest school, who has the direction of forestal excursions and excercises, and is moreover Oberforstmeister of the Canton of Zurich. The course of the instructions extends to two years and a half, beginning in middle of October. The students may hear lectures in the departments of agriculture, philosophy, or political economy. There is a separate laboratory for the agricultural and forestal school.

The attendance of forest-students at the Federal Polytechnic School at Zurich has been, since 1871–'72, as follows:

Year.	Swiss.	Foreign.	Total.
1871–'72	14	4	18
1872–'73	14	3	17
1873–'74	12	2	14
1874–'75	18	4	22
1875–'76	21	3	24

Provision is also made for elementary instruction in forestry in the several cantons, and a practical course for communal foresters has been established, as a means for carrying into more effectual operation the federal law of March 24 ,1876, in relation to the high surveillance of the confederation over the police of forests in the elevated regions. For an account of this sourse of instruction the reader is referred to our chapter upon reboisement in Switzerland, page 377.

FORESTRY INSTRUCTION IN FRANCE.

School of Forestry at Nancy, France.—This school was established in 1825, for the sole purpose of preparing agents for the state forest service, and foresters charged with the management of woodlands belonging to communes and public establishments, the number of pupils admitted being regulated according to the probable wants of the administration, and varying from 8 to 36. During its first fifty years it sent out 992 young men, the annual average being about 20. The school is under the direction of the Ministry of Finances.

Besides these, a limited number of French or foreign students may be admitted, to pursue the course of studies as *externes*. The number of this description is variable, and in 1876 was 10, in the two divisions.

The English Government has an arrangement with that of France, under which three or four students are received annually, who are pursuing their studies with the view of entering the India forest service.

The course of instruction lasts two years, when those who have passed approved examinations are nominated *gardes generaux*, with appointment, and in this capacity remain attached to the school, with the view of completing their theoretical studies and of begining practice in the forest service, for which the forest attached to the institution affords facilities.

Examinations are held at different points in France upon letters of authorization obtained from the director-general of forests, under regulations prescribed, relating chiefly to evidences of age, qualifications, and fitness for the duties of the profession. The course embraces two years, examinations being had at the end of each year, before entering the advanced classes. In 1856, four scholarships were created in favor of sons of forest agents. Those holding them are released from the payment of 1,500 francs annually, as required of others, and receive an annual allowance of 600 francs a year till they get their appointments in the forest service.

The course of studies is as follows:

FIRST YEAR.

Winter term, 10 hours, daily, for 6 months, (November 1 to May 1.)

	Hours.
Forest Economy: Sylviculture; working and delivery of wood, 75 lessons orally of 1½ hours, 112.5; study, 112.5 hours	235
Natural History: Botany, anatomy, organography, physiology, nomenclature, geographical distribution of plants, 75 lessons orally, of 1½ hours each, 112.5; study, 112.5 hours	225
Laws: Organization and attributes of public authority; property and its protection; repression of agencies injurious to forest properties, 50 lessons orally, 75 hours; study, 75 hours	150
Mathematics: Topography, properly so called, and surveying, 20 lessons, orally; roads, 8 lessons, orally; construction, 22 lessons, orally, each of 1½ hours, 75 hours; study, 75 hours; drawing of plans, 162.5 hours	312.5
German language: 50 lessons, orally, 75 hours; study, 37½ hours	112.5
Military instruction: 25 lessons, orally, of 2 hours each; study, 100 hours	250
Horsemanship	75
Free study hours in morning	150
Total	1,500

Summer term, 6 months, (May 1 to November 1, including 4 months for labor and 2 months for vacation.)

	Days.
(A.) *Out-door labors:*	
Forestal and botanical excursions in Aisne, Oise, the Vosges; Doubs, and Jura.	31
Topographical labors; leveling	13
Exercising in surveying	4
Laying out of forest roads	5
Military reconnaissances; shooting	6
(B.) *In-door labors:*	
Preparation of journal of journey, and forestal herbarium	6
Labors and calculations	16
Examinations and preparation	21
Free days	18
Total days in summer term	120

SECOND YEAR.

Winter term, (as in first year).

	Hours.
Forest Economy: Amenagement; estimation, 75 lessons orally, of 1½ hours each, 112.5 hours; study, 112.5	225
Natural History: Mineralogy; study of minerals and rocks; geology and geological description of France, 75 lessons orally, 112.5 hours; study, 112.5 hours.	225
Law: Study of the law of property completed; legal relations of real estate, between personal estate and persons, and between persons; administration of forests subjected to the rules of forestry; 50 lessons orally, 75 hours; studies, 75 hours	150
Mathematics: Topography, part 3; Triangulation, 15 lessons orally; saw mills, 35 lessons orally, 75 hours; studies, 75 hours; drawing, 162.5 hours	312.5
German Language: 50 lessons, 75 hours; studies, 37.5 hours	112.5
Military Instruction: 25 lessons orally, each 2 hours, 50 hours; studies, 100 hours; exercise, 100 hours	250
Horsemanship	75
Free study hours in morning	150
Total	1,500

Summer term, (as in first year).

	Days.
(A.) *Out-door labors:* Exercises of amengement in the forests of Meurthe, and Moselle, and Aisne	23
Triangulations	6
Surveys	2
Study of saw-mills in the Vosges	10
Military reconnoissances; shooting	8
(B.) *In-door labors:*	
Writing a memoir upon the study of amenagement, and reduction of an official plan for the same	14
Designing, calculations, and report	11
Examinations and preparation	28
Free days	18
Total days in summer term	120

THIRD YEAR, (Theoretical instruction.)

Winter term, 5 months, (November 1 to March 31.)

	Hours.
Forest Economy: Forest statistics; political economy, 40 lessons orally of 1½ lessons each	60
Natural History: General, forestal, and agricultural zoölogy, 40 lessons orally	60
Law: Law of the chase; fixing of dunes; reboisement and sodding of mountains, 20 lessons orally	30
principles of administration and management of a cantonnement, 40 lessons orally, each 3 nours	120
Agriculture: Laws of vegetable and animal production; agriculture proper, 40 lessons orally	60
German Language: 40 lessons orally	60
Total	390

Gardes-generaux of the first stage are allowed to work freely, without being required to assist in the studies.

(Practical instruetion.)

Office-work: Two days are devoted in each week to the office of inspection, and to the various administrative duties relative to the current service.
Forest-work: Two days in each week are given to various reconnaissances, the supervision of workings, surveys, study of domainal and commercial series, etc.

Summer term, 5 months, (April 1 to August 31.)

April: Participation in all the operations of marking and of cutting in the domainal and communal forests under the care of the school, preparation of reports of marking, estimation and cutting.
May, June, and July: Forestal journey into the high-forests of oak in Central France;

the fir-forests of the Vosges and Jura, and the region of reboisement and sodding in the Alps.

August: Preparation and sending of a personal memoir upon this forest journey; examination.

[The programme of instruction, embracing a classified statement of the points upon which knowledge is required at this forest school, as published in 1876, fills 118 quarto pages.]

Attendance at the School of Forestry at Nancy.

Year.	Number.	Year.	Number.	Year.	Number.	Year.	Number.	Year.	Number.
1826	11	1836	8	1846	22	1856	30	1866	29
1827	10	1837	10	1847	28	1857	21+2	1867	35
1828	14	1838	10	1848	24	1858	24+1	1868	32
1829	12	1839	16	1849	25	1859	32	1869	36
1830	11	1840	14	1850	23	1860	22	1870	......
1831	13	1841	18	1851	14	1861	30	1871	27
1832	11	1842	15	1852	13	1862	34	1872	26
1833	11	1843	18	1853	11	1863	27+1	1873	14
1834	11	1844	15	1854	21	1864	28	1874	17
1835	11	1845	19	1855	20+2	1865	35	1875	12

Where two numbers are given with a plus sign between, the first shows the number of regular promotions in the service, and the second the number in the "civil list." We are indebted to Prof. A. Mathieu, sub director and professor of Natural History, for documents and other information concerning this institution.

The forests connected with this school, in the department of Meurthe and Moselle, embrace 9,259 acres belonging to the state, and 4,205 to communes; in all, 33,244 acres.

School of Forest Guards at Barres.—In 1865, M. Vicaire, then director-general of forests, conceived the idea of purchasing the property of Barres, where M. Vilmorin, an eminent arboriculturist, had formed, as early as 1821, some plantations of exotic trees, from seeds received of correspondents. This having attracted the attention of the Central Society of Agriculture, the purchase was made in June, 1856, after the death of M. Vilmorin, and included the chateau and other buildings, with 166½ acres of land, at a price of 75,000 francs. It is about 11 miles south of Montargis, and three-fourths of a mile from the station of Nogent-sur-Vernisson. One of the conditions imposed by the vendors was, that it should be known as the "Vilmorin Establishment for Practical Arboriculture." Towards the close of 1866, M. Gouët, then sub-inspector of forests, was appointed to take charge of the existing collections, and continue the work of naturalization then begun. The nurseries were enlarged, and various improvements made.[1]

[1] In 1869 the plan of usefulness was enlarged, and the establishment now embraces—

1. A School of Guards.
2. The central repository and station for trial of forest-seeds.
3. Station for meteorological observations, and for determining the resistance of woods.
4. The central nurseries and naturalization station.
5. Massive growths of exotic trees.

The school is intended for practical instruction in sylviculture as a preparation for the duties of forest-guards. Besides the use and care of arms, and the discipline proper in such an institution, the pupils are subjected to a theoretical course, and to practical exercises, the former including orthography, writing, drawing, arithmetic, botany, and the elements of sylviculture; and the latter the care of woodlands and nurseries, and various forest operations, as well upon the estate as in neighboring forests, with some knowledge of forest law and administration. The school is supplied with collections of specimens of wood and seeds, a forestal library, instruments, and models, and in short with whatever may tend to promote an interest in study and a habit of observation. New arrangements are in progress which will bring the number of pupils in the two classes up to eighty. They must show sufficient acquaintance with primary studies at time of entering.

L'Institut Agronomique.—There has been recently established at the conservatory of arts and trades in Paris, under a law of July 27, 1872, an agronomic institute, having for its object the elevation of the grade of agricultural science in its relations to the various branches of animal and vegetable production. Pupils are not to be admitted under 18 years of age, and they must bring the diploma of a bachelor of science, or pass an examination showing that they possess the attainments corresponding with this degree. The course of instruction is to embrace two years, and upon passing the examinations prescribed for graduation, the students are to receive a diploma of superior instruction in agriculture. Fees, 300 francs per annum. Some stipends are provided, and auditors may be admitted who do not participate in the full course, nor are these admitted to the study-rooms or laboratories.

On the 9th of October, 1876, the faculty of this new institution was organized by a decree of the Minister of Agriculture and Commerce, appointing fifteen professors, of which several will have direct or indirect charge of matters relating to forestry.

Instruction in Forestry at Schools of Agriculture.—Besides the foregoing, it is customary for the French forest administration to detail agents for instructing classes upon the general principles of forestry at several of the agricultural schools in France, upon the plan we follow in appointing Army officers for giving military instruction at certain colleges and universities. The *Annuaire des Eaux et Forêts*, for 1877, shows a sub-inspector, as professor of horticulture, sylviculture, and vegetable physiology in the agricultural school of Roanne (Loire), and an inspector, as professor of sylviculture and botany, in the agricultural school of Montpelier (Hérault).

SCHOOL OF FORESTRY AT VALLOMBROSA, ITALY.

This school was created by royal decree, dated April 4, 1869. It is located in the midst of a fine forest of the silver fir, in the old convent of Saint Gualbert, pleasantly associated with the names of Milton and of Byron, and about eighteen miles from Florence. It is at an elevated point on the slope of the Apeninnes, near the source of the Arno, and the topography and geological conditions of the neighborhood are quite interesting and varied. In winter, the school descends to Paterno, in the valley of the Arno, and half way between the station at Vallombrosa and the railroad station of Pontassicol. Several provinces of the kingdom, at the beginning voted to advance funds to students of the Royal School of Engineers, to enable them to attend the course. The plan of organization is not essentially different from that of the school at Nancy, and the institution is under the direction of A. di Berenger, inspector-general of waters and forests.

This school was first opened August 23, 1869, in the presence of several senators and officials, connected with the ministry of agriculture, industry, and commerce.

SPAIN.

Special School of Forest Engineers.—By a royal decree, dated May 1, 1835, and by direction of the regent, dated May 18, 1843, there was created a school of forest engineers, which, on the 18th of November, 1846, was located at Villaviciosa de Odon, from whence it was transferred, by decree of October 25, 1869, to San Lorenzo del Escorial, near Madrid. It is under the direction of the minister of agriculture, and has for its object the preparation of candidates for the forest service.

It is one of the twenty-two meteorological stations established by the general statistical commission of the kingdom.[1]

PORTUGAL.

In 1852, an agricultural institute was formed in Lisbon, and in 1855 a veterinary school was united. In 1865 it was reorganized as the "General Institute of Agriculture," the course embracing rural engineering, agronomy, sylviculture, and forest engineering, and veterinary medicine. The school has ten professors of the first class and five substitutes. It is located at Cruz de Taboado, in the suburbs of Lisbon, and has botanical and agricultural gardens, cabinets, and collections for practical instruction.

DENMARK.

The Royal Veterinary and Agricultural High School at Copenhagen was established March 18, 1856, and, on the 22d of January, 1869, a department of forestry was annexed.

SCHOOLS OF FORESTRY IN RUSSIA.

The Agricultural and Forestal Academy of Pétrovsk was established in 1865, near Moscow, and is designed to give young men superior instructions in all branches of the agronomic sciences as well as in sylviculture. The pupils pursuing the academic course may pass an examination in the section of general agriculture or in the special section of sylviculture. Before entering the academy, students must have finished the course of instructions taught in the gymnasia.

The Agronomic Institute at Saint Petersburg was organized in 1848 at the city of Gorki, in the government of Mohilew, in place of a superior school of agriculture, which had existed there since 1842. It was removed to Saint Petersburg in 1865.

Like the academy at Pétrovsk, the Agronomic Institute has for its object to give young men superior instruction in agriculture and sylviculture, and for this purpose it is organized in two sections, agronomy and sylviculture. The rules for entering the institute, the course of instruction, and the rights of those who have finished the course are the same as at Pétrovsk.

Forest School at Lissino.—Besides the institutions above mentioned, there is in the government of Saint Petersburg, and 70 versts (46⅓ miles) from the city, in the village

---

[1] Candidates for admission are examined in elementary mechanics, descriptive geometry in its application to shadows and perspective, physics, general chemistry, natural history, linear and topographical drawing, French, and German. They must have passed in the schools the Spanish grammar, Latin grammar, geography, general history, and the history of Spain.

The course of instruction lasts three years, of which the first includes topography, surveying, stereometry, and applied mechanics; the second includes chemistry, mineralogy, botany, zoölogy, and practical geology; and the third, forestal construction, sylviculture, management of woodlands, political economy, and administrative affairs.

By a decree, dated May 25, 1877, it has been ordered, that beginning in June, 1878, applicants for admission to the schools of Roads and Mines, and of Forestry, shall be examined upon the following subjects, viz, arithmetic, algebra, geometry, trigonometry, analytical geometry, and the infinitesimal calculus, linear and topographical drawing, mechanics, physics and chemistry. Rules are prescribed for conducting the examinations, and for the publication of notices.

Number that have received the title of forest engineers at the Spanish School of Forestry since its organization.

Years.	Number.	Years.	Number.	Years.	Number.	Years.	Number.	Years.	Number.
1851	4	1856	6	1861	1	1867	8	1872	5
1852	31	1857	7	1862	2	1868	12	1873	6
1853	6	1858	2	1864	8	1869	11	1874	2
1854	9	1859	3	1865	11	1870	16	1875	3
1855	6	1860	4	1866	12	1871	14	1876	4

(*Revista de Montes*, No. 9, p. 209; No. 11, p. 252.)

of Lissino, a forest school of the second class. The pupils leaving this school receive the rank of forest conductors, holding the places of forest aid agents and forest agents of the fourth class. The course of studies at this school is practical, and the course studies extends to three years.

Forest Division of the Agricultural and Forest Institute at New Alexandria.—Founded by imperial decree of June 8, 1869, and located in one of the most beautiful sections of Poland, on the banks of the Weichsel. The premises formerly belonged to Prince Gartovysky, and are about 100 versts (60.6 miles) from the city of Warsaw. It is surrounded by a fine park, adorned with fountains and grottoes. There are three farms, with an aggregate of about 900 acres, belonging to the institute. The institution is under the care of the Minister of Public Instruction in means of instruction, and as it does not secure to its students employment in the state service, its attractions are less than at some others. Since its opening, eight years since, the degree of "Learned Forester" has been conferred upon but nine students.

FOREST SCHOOL IN FINLAND.

In 1858 Baron von Berg, *Oberforstrath* in Saxony, was invited to visit professionally, and to examine and report upon the condition and management of the state forests of Finland. He did so, and in pursuance of his recommendation there was established, by decree dated March 10, 1859, a forest school, for the instruction of canditates for employment in the forest service, at the crown park of Evois, in Lampes-socken, in Tavastnhus-län. It was opened April 15, of that year, fully organized, and placed under the charge of a director and three resident lecturers and one field instructor.[1]

ROYAL FOREST INSTITUTE AT STOCKHOLM.

This was established by a royal order dated October 15, 1828, and reorganized May 25, 1860. It is placed under the management of a director and four teachers appointed by the King, on the nomination of the forest administration, one for the care and management of forests, one hunting and forest laws, one natural history, and one mathematics. Assistance is granted to pupils by a certain number of stipends, the amount being separately fixed, and assigned to such indigent students as may deserve them through industry, skill, and good conduct.[2]

Provision is also made for the establishment of other forest schools at suitable localities, under the superintendence of the nearest district director of forests, and with a teacher appointed by the King, on the proposal of the governor of the province, assisted by a ranger. The instruction at these schools embraces the first four rules of arithmetic, proportion, and decimal numbers; knowledge of scales for plan-drawing, so far as required for making maps and measuring distances; knowledge of square and cubic measures, with practical application to the measuring of the extent and contents of surfaces and solid bodies; knowledge of the nourishing organs of the forest trees and of their food, and the natural conditions for their thriving; knowledge of the most dangerous insects of the Swedish forests, and of the manner of destroying them; the chief principles of rational forest economy, and knowledge of the rules existing for the peace and keeping of forests, marking and carrying of timber, hunting, and also the leading form for entering charges. The pupils are also to be practiced in marking out and measuring forest-lines, tilling-places, and sowing-fields; calculating the cubic contents of trees and timber; the position of seed trees; sowing for hand and planting, as well as the preparing of the soil for forest-growing; collecting and assorting forest seeds; clearing and cutting, assorting and piling timber; marking cattle and the making out of grazing-lists; laying up and keeping patrol-lists; making out lists of unlawfully-felled timber, on which embargo has been laid; monthly reports and service-accounts; the trapping of beasts, and the grand chase. This course extends one year, and ends with a public examination, successful pupils receiving a certificate of approved school. In 1874 seven such schools were reported as existing, viz, at Sillre, Tierps, Ombergs, Hunnebergs, Böda, Danielslund, and a mixed school at Skogsball.

Assistance is also promised by the government in the establishment of private forest schools, upon condition that the community where located furnish apartments and pay for maintenance of the school, and that a report is made yearly to the forest administration.

In 1870 there were 13 private elementary schools of forestry.

---

[1] Brown's *Schools of Forestry in Europe.*

[2] Ample information upon the organization of this school is given in a *Report to the Department of State, on the Forests and Forest Culture of Sweden*, by the Hon. C. C. ANDREWS, minister resident of the United States to Sweden and Norway, dated August 5, 1872. We are also indebted to General Andrews for much other information concerning forestry in Sweden and Norway.

INDEX.